SCIENCE.

FRIDAY, APRIL 25, 1884.

COMMENT AND CRITICISM.

THE National academy of sciences, which met at Washington last week, labors under a serious disadvantage in being able to meet but twice a year; more frequent meetings of a society whose membership extends over the entire country being impossible under present conditions. Notwithstanding this disadvantage, it is of the highest importance that the leading scientific workers of the country should form an organized body; and the academy seems to fulfil the objects of such an organization as well as any that could be devised. It is hampered by no rules that do not admit of being amended whenever it is found necessary so to do, and there is no limit upon the membership except what the academy may itself see fit to impose. The infrequency of its meetings does not prevent it from being always ready for action on any subject referred to it by congress, or any department of the government. The president of the academy can at any time appoint a committee of experts to investigate and report upon the questions submitted, and he has authority to accept the report of such a committee. At first sight, this system might seem to place too much power in the hands of the president and any committee he chooses to name; but, practically, the danger of this power being abused is no greater than in all human affairs. Important reports are submitted to the academy for approval whenever practicable; but even then the academy can seldom or never do better than accept the opinion of the experts who have investigated the subject. The varied applications of science are now so highly specialized, that conclusions depend more upon a minute examination of details, such as only a committee can enter upon, than upon general opinions.

The most important functions of the academy are those which grow out of its relations to the government. The liberal spirit which animates both congress and the executive departments in their dealings with scientific affairs is very apt to lead them into the support of scientific enterprises without any sufficient consideration of the conditions of success and of efficient and economical administration; and a careful consideration of each proposed undertaking by a committee of experts is what is wanted to insure the adoption of the best methods. Indeed, it is worthy of consideration, whether congress would not do well to adopt the principle that it would make no appropriation for a new scientific object unless the plan of operations were first submitted to and approved by the academy.

OLEOMARGARINE, suine, and all forms of imitated and adulterated butter, receive heroic treatment by the legislature of New York. A bill has passed the senate by a vote of twenty-five to four, and the assembly by ninety-nine to one, which absolutely prohibits the manufacture or sale of bogus butter within the state. Penalties in fines of from fifty to a hundred dollars are imposed for violations of the act; and a dairy commissioner, appointed by the governor, with a salary of three thousand dollars, is to be allowed twenty thousand dollars with which to enforce the statute. At this writing, the bill only awaits the signature of Gov. Cleveland to become a law, and go into effect the first day of June.

This action resulted from an order of the senate, to its committee on public health, to inquire into the adulteration of food and dairy products. Various agricultural organizations had previously pressed the matter upon the legislature; the State dairymen's association sending an active committee to Albany to look after it, and furnishing counsel for the senate

committee. The latter, with Senator Low of Orange county as chairman, made a vigorous campaign, gave public hearings at Albany and New York, aroused popular interest, and submitted an elaborate report. The investigation was extremely one-sided throughout, and the facts were absurdly exaggerated and distorted; as, for example, when it was seriously argued that the factory manipulation of butterine generated loathsome diseases among employees, and that the extending use of imitation-butter caused an increase in the death-rate of New-York City.

The main points brought out by the inquiry were these: that previous laws of restriction and regulation were ignored because no proper provision was made to execute them; that while the imitations and adulterations of butter were generally known where handled in the wholesale trade, and changed hands without deception, although often unmarked, these articles were almost uniformly fraudulently retailed as real butter; that farmers and merchants, including exporters, believed the production and sales of genuine dairy-products to be suffering from the frauds; that the later modes of manufacture were less cleanly and healthful than when oleomargarine was first made; that nitric acid and other objectionable substances were carelessly used in the newer processes; and that honest dairymen were being induced, under pressure of competition, to buy oleo-oil and 'neutral lard' (deodorized low-grade fats) to extend the quantity of home-made dairy-products.

Missouri is the only state which has, previous to New York, adopted the policy of prohibition as a cure for dairy frauds. The result will be watched with interest. Although under active management, supported by popular prejudice, this extreme legislation has been secured almost unopposed, there are those who doubt its wisdom, both as regards cheap food, and the true dairy interests of the great dairy state. The matter is also being agitated in New Jersey and Pennsylvania.

Attention was called in one of our previous numbers to the difficulty experienced by the signal-service in securing young men, well trained in meteorology, for scientific work in the central office at Washington, on account of the lack of adequate instruction on this subject in our universities. Signal-service note, no. ix., prepared by Mr. Frank Waldo, after a year's residence in Germany, on the study of meteorology in the higher schools of Germany, Switzerland, and Austria, shows how much more attention is there devoted to this growing subject, although in many universities or technical schools it is taught only in an elementary way, or not at all. Such names as Hann, Oberbeck, Simony, Sohncke, Supan, Thiesen, Zöppritz, appear on the list here given; all of these professors giving original lectures. The chief reason for this latter point is, we may suppose, because no text-book has appeared which fully represents the present attitude of the new meteorology. In the absence of any serious modern treatise, articles in scientific journals form the main source of the newer material not original with the instructor. Workers in this country may therefore congratulate themselves on the opportunity for technical publication and discussion now offered in the American meteorological journal lately announced.

New Jersey is in a fair way to be the first state in the Union provided with a good topographical map. About a year ago we described the two sheets of the northern part of the state then issued. The considerable progress achieved since then is now detailed in our notes, together with the plans for the future. Professor Cook, director of the geological survey of New Jersey, states, in his recent annual report, that the topographical sheets already published have been very generally approved, and are now in demand for the laying-out of water-supply and drainage works, roads and railroads. The work is one that New Jersey may well be proud of, and that other states must envy.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

'A singular optical phenomenon.'

THE 'singular optical phenomenon' described by 'F. J. S.' on p. 275 of the current volume of *Science* is a case of the familiar *watering* effect produced by superposed loose and regular fabrics, or by distant palings and lattice-works superposed by projection. We may find it convenient, in the following discussion, to refer to these by the general term of 'projection phenomena,' although the phrase does not seem to me to have much to recommend it except convenience.

I ought to say that this discussion is prompted by the letter by Professor LeConte in the last number of *Science;* for, if so skilled an experimenter could overlook the real explanation, it may safely be concluded that most readers have done so. Moreover, the phenomenon is one of a large and interesting class, of which I have never met any explanation, although, as we shall see, very simple considerations will lead us far towards a complete explanation of all.

For the sake of simplicity, we will begin by the consideration of two gratings of regular horizontal elements: the one nearer the observer, which we will call the first grating, is to be of alternating opaque and transparent strips; and the more distant one, or second grating, of white and black bands. We will also suppose, at first, that the eye is placed in a line passing through the middle of a dark band and an opaque strip, and that the aperture of the pupil is negligibly small. We may also conveniently assume that the angular widths of the elements of both gratings are so small that they are not separately evident to the eye, not only because such cases offer the most striking phenomena, but also because in them the meaning of the term 'apparent brightness,' which we shall use, is self-evident.

We will call the distances from the eye to the screens respectively d_1 and d_2; the breadths of the opaque and black intervals, b_1 and b_2; and, finally, the element of each grating (that is, the distance from the centre of one dark strip to the centre of the next), E_1 and E_2.

If B is the brightness of the white portion of the second grating, it is evident that the average brightness of the field, if the first grating were removed, would be

$$B\,\frac{E_2 - b_2}{E_2}.$$

If, on the other hand, the first screen remained in place, and the black strips of the second should be replaced by white of brightness B, the field would appear of a brightness

$$B\,\frac{E_1 - b_1}{E_1}.$$

As a first special case, let us suppose

$$\frac{E_1}{d_1} = \frac{E_2}{d_2};$$

then, remembering the position of the eye, it is clear that each opaque bar would be centrally projected upon a dark strip of the second grating; and the brightness would be uniform, and equal to the less of the two expressions above.

For a second case, suppose

$$\frac{E_1}{d_1} = n\,\frac{E_2}{d_2},$$

n being any whole number: then every nth black strip would be centrally covered by a bar of the first grating. If $\frac{b_1}{d_1}$ is equal to or less than $\frac{b_2}{d_2}$, the brightness would be uniform, and equal to $B\,\frac{E_2 - b_2}{E_2}$; but, if this limit of equality were surpassed, the average brightness would be

$$B\,\frac{nE_2 - (n-1)\,b_2 - b_1\frac{d_2}{d_1}}{nE_2},$$

and there would be regularly placed minima, unless the angle $\frac{nE_2}{d_2}$ were insensible to the eye.

The case of $n\,\frac{E_1}{d_1} = \frac{E_2}{d^2}$ is equally easy.

In all that follows, we will, in order to avoid too extensive discussion, regard n as equal to unity: by this limitation we sacrifice no interesting cases.

Suppose, now, the eye moved continuously up or down, parallel to the gratings. After a certain small displacement, depending upon the relation of $\frac{b_1}{d_1}$ to $\frac{b_2}{d_2}$, the brightness of the field would continuously diminish until it reached a minimum equal to

$$B\,\frac{E_2 - b_2 - b_1\frac{d_2}{d_1}}{E_2},$$

unless the numerator should be negative, when the minimum would be absolute. It would remain at this minimum for a certain time, depending upon the constants of the system, and then increase by exactly the same law as that of decrease, until after a displacement of the eye equal to $E_1\,\frac{d_2}{d_2 - d_1}$, when it would recur to the same condition as at first.

As a final and more general case, let us suppose that

$$\frac{E_1}{d_1} = \frac{E_2 + \delta}{d_2},$$

where δ is a small quantity, positive or negative. If we again suppose that the eye is so placed that a line drawn from it perpendicularly to the two gratings will pass centrally through dark bars in each, then a line drawn from the eye through the mth bar of the first grating will pass through a dark strip of the second, if $\frac{m\delta}{d_2}$ is a whole number. Let m be the *smallest* number which meets this condition: then a line drawn through any bar between the 1st and mth would meet some one of the conditions discussed in the last paragraph, as produced by a movement of the eye. Thus we see that the field would present horizontal maxima and minima of brightness, the angular position (θ) of the maxima being given by the equation

$$\theta = \text{tang}^{-1}\,N\,\frac{mE_1}{d_1}$$

where N is any whole number, positive or negative. The apparent distance apart of the maxima would be $\frac{m\,E_1}{d_1}$.

If the eye be moved so as to shift the apparent position of the central bar to the adjacent black strip on the second grating, the middle of the field would have undergone all the changes of phase which correspond to a change of tang θ from zero to $\frac{m\,E_1}{d_1}$; hence such a motion of the eye would appear to give

rise to a shifting of the whole series of maxima by this angle. The direction of apparent motion would be either with that of the eye, or opposite, according as δ is positive or negative. The displacement of the pupil necessary to bring about this change would be

$$E_2 \frac{d_1}{d_2 - d_1}.$$

If the relative motion of the periodic phenomenon and the first screen be regarded as a parallactic displacement, then we must suppose their relative distances from the eye inversely proportional to their apparent motions; i.e., as

$$\frac{mE_1}{d_1} \text{ to } \frac{E_2}{d_2 - d_1};$$

or, since $\frac{E_1}{d_1} = \frac{E_2}{d_2}$ nearly, as m to $\frac{d_2}{d_2 - d_1}$.

It was this apparent parallax which led 'F. J. S.' to suppose the phenomenon which he describes an image of the distant screen between himself and the first window.

If our gratings be complicated by the addition of equally spaced vertical bars, we shall see also, in general, a series of vertical bands giving maxima and minima along a horizontal direction. These will be separated by intervals

$$\frac{m' E_1'}{d_1};$$

and the ratio of their apparent angular motion to that of the first screen when the eye is moved equals

$$m' \text{ to } \frac{d_2}{d_2 - d_1},$$

where the letters marked with $'$ are defined by analogy.

A very interesting conclusion follows from the consideration that m and m' are wholly independent; the one depending on δ, and the other on δ'. Thus, we may have the horizontal bands moving in the same direction as the eye, and the vertical bands moving in the opposite direction, or *vice versa:* hence, if the displacement of the eye is neither horizontal nor vertical, the network which forms the projection phenomenon may seem to move in any direction, the only condition being that the horizontal and vertical components of the velocity are proportional, respectively, to m' and m; or, in other words, to the apparent width of the bands, divided by the corresponding element of the first grating.

In the case of gratings which are not plane, superposed by projection, as is the condition generally with doubled laces, veils, mosquito-bars, etc., — in short, in almost all cases of every-day observation, — both δ and δ', as well as the direction of the elements of the gratings, are functions of the distances from the central point of the field; but, as these are continuous functions, we can state several of the most important properties of the projection phenomena: viz., —

1°. The bands will be continuous and curved. 2°. If the eye be moved, the phenomenon will shift with an apparent velocity in any direction proportional to the width of the bands measured in that direction. 3°. The motion of a single band will, in general, be a motion of translation, combined with a motion of rotation. But the instantaneous centre of rotation cannot lie in a band; for in that case, according to the previous conclusion, that point being at rest, the band would there have no width, consequently could not exist. 4°. If a band forms a closed curve, a motion of the eye will necessarily produce a continuous change in the apparent magnitude of the ring; for a mere motion of translation would correspond to a momentary rotation about at least two points in the curve, which, according to the last principle, is impossible.

The properties described under the second and fourth heads above are those which more especially cause the projection phenomena to resemble those of watered silk; for the latter follow much the same law.

We will now consider the effect of the size of the pupil of the observing eye, which has hitherto been considered as a point. It is obvious that the image on the retina must be the sum of the projection images as seen from each point of the pupil: hence, if the pupil is not much greater than the space through which the point of view must be shifted in order to produce a complete change of phase (i.e., than $E_2 \frac{d_1}{d_2 - d_1}$), the phenomenon must be like that for an indefinitely small pupil, except that the discontinuity is less pronounced. This explains why, in fine networks, such as veils and mosquito-bars, the distance $d_2 - d_1$ between the fabrics must be small in order to produce the projection phenomena. In the case described by 'F. J. S.,' $E_2 = \frac{1}{4}$ inch, $d_1 = 10$ feet, and $d_2 = 40$ feet: consequently the expression indicating the limit which the diameter of the pupil must not greatly surpass is $\frac{1}{6}$ inch.

The effect of maladjustment of the eye would be to diminish still further the discontinuity of the phenomenon; but this would be carried so far as to destroy the periodicity, and thus obliterate the phenomenon, — not when an angular interval of $\frac{E_2}{d_2}$ at the distance d_2 becomes indistinguishable, as 'F. J. S.' seems to have expected, but only when an angular interval of $\frac{mE_1}{d_1}$ at the distance d_1 becomes indistinguishable.

The cases where n differs from unity offer no difficulties, but they are much less interesting. They exclude the case which has given rise to this discussion; for there E_1 equals $\frac{1}{8}$ inch, the other dimensions having been already quoted.

In what precedes, however, I have tacitly assumed that $\frac{\delta}{d_2}$ is always the reciprocal of a whole number. This may not be true. Suppose the value to lie between $\frac{1}{N}$ and $\frac{1}{N+1}$, where N is a whole number: then, if N is large, the solution above is accurate within the range of observation. If, on the contrary, the value of N is moderate, successive maxima will differ by a quantity which is itself periodic.

It will be observed that the second grating may be perfectly replaced by an image by reflection of the first. Frequent examples of this arrangement are seen in screens before closed windows or mirrors.

The general analytical solution of the whole class of phenomena produced by parallel rectangular gratings with indefinitely small pupil is easy; but the solution is so extremely general, that its reduction to special interesting cases requires even more writing than we have found necessary here. The only point worth dwelling upon here is, that the apparent variations in brightness, though periodic, are always discontinuous; but that every departure from the assumed geometrical conditions, such as are effected by diffraction, dimension of the pupil, and imperfect accommodation, tends to decrease the discontinuity.

C. S. HASTINGS.

Baltimore, April 11.

Rhythmic variation.

It is a general axiom in 'breeding' and in allied biological discussions, that 'like produces like;' and yet in nature, or under art, we have no instance we can use where like has produced an identical likeness. It rather seems that the practical expression should be the converse one, that 'variation produces variation;' for in nature we find variation the general fact, no animal and no plant producing offspring precisely similar to itself. Indeed, as the attribute of life is motion and but momentary equilibrium between internal and external forces, we may consider variation as an empirical law of nature, and as influenced by the law of rhythm, as outlined by Herbert Spencer, who says that rhythm results wherever there is a conflict of forces not in equilibrium.

This law of rhythm seems sufficient to explain, in part or in whole, some of the variations observed in species, and for which neither natural nor sexual selection can account. Given organisms under similar environment, and remote from selective opportunity, we must believe that variations must occur; and these variations must naturally become grouped about types under the action of heredity and some other general laws, giving through rhythmic action the appearance of progressive development.

Probably this law of rhythmic movement may explain the interesting variations which have originated species in certain protoplasmic organisms, as so well described by Professor Asa Gray (*Amer. journ. sc.*, April, 1884, 327), who says, —

"No exercise of 'natural selection' could produce the successive changes presented in the evolutionary history of the typical Orbitolites, from Cornospira to Spiroloculina, from Spiroloculina to Peneroplis, from Peneroplis to Orbiculina, from Orbiculina to the 'simple' forms of Orbitolites, and from the 'simple' to the 'complex' forms of the last-named type. And as all these earlier forms still flourish under conditions which (so far as can be ascertained) are precisely the same, there is no ground to believe that any one of them is better fitted to survive than another. They all imbibe their nourishment in the same mode, and no one type has more power of going in search of it than another. That they are all dependent on essentially the same conditions of temperature and depth of water, is shown by their occurrence in the same marine areas. That they all equally serve as food to larger marine animals, can scarcely be doubted; and it is hardly conceivable that any of their devourers would discriminate (for example) between the disks of a large O. marginalis, or middle-sized O. duplex, and a small O. complanata, which even the trained eye of the naturalist cannot distinguish without the assistance of a magnifying-glass."

E. LEWIS STURTEVANT.

Geneva, N.Y., April 12.

Rare Vermont birds.

In a list of birds given under this heading in No. 55 of *Science*, appeared the American avocet (Recurvirostra americana Gm.) and orange-crowned warbler (Helminthophaga celata Say, Bd.). It appears, these were admitted on mistaken evidence, and are not to be considered as Vermont birds.

FRANCIS H. HERRICK.

THE APRIL SESSION OF THE NATIONAL ACADEMY OF SCIENCES.

THE number of papers presented at the session of the National academy of sciences in Washington last week was less than usual, and, judging from the discussions, none were of commanding interest and importance. An unusual number of prominent members were absent from the meeting; and it also happened that the social re-unions which have usually accompanied the annual session were, from various accidental circumstances, omitted. It has long been a custom, if not an unwritten law, of the academy, to decline all social attentions which do not come either from members or officers of the academy, or from heads of government departments interested in its work.

An interesting feature of the meeting was a communication received from Mrs. J. Lawrence Smith, widow of the late lamented chemist of Louisville, proposing to give the sum of eight thousand dollars, which she had received from Harvard college by the sale of Professor Smith's collection of meteorites, to establish a memorial fund for the promotion of meteoric research. The academy will then have four considerable funds for the promotion of science, — the Bache, Draper, Watson, and Smith funds.

The following were some of the more interesting of the physical papers: —

It has long been a well-known result of theoretical mechanics, that the rotation of the earth causes a slight tendency in any southward-flowing river of the northern hemisphere to press towards its right bank; and various phenomena have been attributed to this, among others a supposed tendency of driftwood to accumulate on the right rather than on the left bank. It is, however, readily shown that this tendency could not produce this effect; and the general conclusion has been, that the only effect would be an imperceptible difference of level of the two sides of the river. The object of the first paper read — that of Mr. Gilbert, on the deflection of river-courses in consequence of terrestrial rotation — was to point out an indirect result of the forces in question, which had hitherto been overlooked, and which might produce observable results. He showed that the effect of terrestrial rotation is to increase the centrifugal force on those curves which deflect the river from the right towards the left, and to diminish the force in the opposite direction; the difference in the case of the Mississippi River being about one-tenth part of the whole.

In his paper on the origin of crystalline rocks, Dr. Sterry Hunt conceived that rocks, like gneiss and other felspathic, hornblendic, and quartzose aggregates, resulted from the action of water on the superficial and last congealed part of the earth's crust, through upward lixiviation. The separation of zeolites and quartz from basic rocks is a survival of this process of deposition from mineral springs,

whose action divided the primitive rock into a lower basic and an upper acidic portion. The author distinguishes this by the name of the crinitic hypothesis.

In continuation of the series of researches which he has been making upon solar and terrestrial radiation, Professor Langley presented a short paper on the character of the heat radiated from the soil. It is a commonly accepted opinion, that the atmosphere is less transparent to the invisible heat-rays of the sun than to the visible light-rays, and that the heat stored in the atmosphere is due to this cause. His researches had, however, shown, that, so far as solar radiation is concerned, this view was ill founded, since the solar rays of longest wave-length pass as freely through the atmosphere as the visible red rays. But, when the radiation from a metallic surface heated to the temperature of boiling water was measured, rays were found of a wave-length far exceeding any that had been measured in the solar spectrum. As it could not be considered probable that such rays were really wanting in the heat emitted by the sun, he reached the conclusion that they were absorbed by the atmosphere, which should therefore be regarded as opaque to such rays. This being the case, all or nearly all the heat radiated by the soil would be intercepted by the atmosphere; and thus we have the heat-storing effect to which the temperature of our globe is to be attributed. Incidentally Professor Langley expressed his entire dissent from the conclusion of Herschel and Ross respecting the heat radiated by the moon. The latter had attempted to differentiate the heat reflected by the moon from that radiated, and to determine the latter, and thus reach a conclusion respecting the temperature of the lunar surface. The conclusion of Professor Langley's researches was, that the heat radiated by the moon could no more penetrate our atmosphere, so as to be absorbed on the earth's surface, than it could penetrate the armor of a ship of war, and that its supposed measure must therefore be illusory. He also expressed the opinion, that the temperature of the moon under the influence of the full radiation of the sun, instead of being several hundred degrees Fahrenheit, as Herschel had supposed, was more likely very far below the lowest known on our globe.

Dr. Hilgard made a communication on the depth of the western part of the Atlantic Ocean and Gulf of Mexico with respect to the Gulf Stream. His remarks were illustrated by a model in relief, showing the configuration of the whole country east of the Mississippi River, and of the bottom of the Atlantic Ocean and Gulf of Mexico. The very slow rate at which the depth of the ocean diminished until the Gulf Stream was reached, and the rapidity with which it then shelved off, were very strikingly shown by the model. Dr. Hilgard also gave an account of the progress of the work of the coast-survey in connecting the Atlantic and Pacific coasts and the Gulf of Mexico by precise levellings. The work has been in charge of a single assistant, and has been carried 1,784 kilometres from New York, past St. Louis. The datum-point at St. Louis has been determined to be 126.91 metres above mean sea-level at Sandy Hook, with a probable error of 48 millimetres. By three sets of levellings, which have been made by different parties in the Mississippi valley, from St. Louis to the Gulf, and which are, in part, of unknown value, it would appear that the mean sea-level of the Gulf at New Orleans was one metre higher than that of the Atlantic Ocean at Sandy Hook, — a difference deemed probably greater than fact.

Mr. H. M. Paul of the naval observatory read a short paper on the Krakatoa atmospheric waves. He had made a copy of the curves of atmospheric pressure on the days in question, as registered at the signal-office in Washington, and reached conclusions similar to those of Gen. Strachey and others. He also showed that waves of the same kind had been recorded at other times on the register.

Several of the papers presented on the biological side were the direct result of the explorations of the U. S. fish-commission steamer Albatross. One of more than usual general interest was that of Prof. A. E. Verrill, who gave an account of some of the zoölogical results of the deep-sea dredgings between Cape Hatteras and Nova Scotia, using the model exhibited by Dr. Hilgard to illustrate his remarks. The number of additions to our fauna was surprising, including many new family and generic types in fishes, crustaceans, mollusks, echinoderms, and other of the lower invertebrates, and many whose nearest allies were inhabitants of distant seas. The dredgings were from two thousand to three thousand fathoms.

Dr. Gill and Mr. Ryder's paper on the Lyomeri exposed the characters of an extraordinary type of deep-sea teleost fishes, having, among other characteristics, no branchiostegal and pharyngeal, and only rudimentary branchial arches; an imperfectly ossified cranium; only two cephalic arches, — a maxillary and a suspensorial; no palatopterygoid and an imperfect scapular arch. The remarkable deviations

from the ordinary fish-type can be explained on teleological grounds. The enormous development of the jaws throws the branchial apparatus out of place, and entails its eventual degradation. The peculiar construction of the mouth, and opposability of the jaws, appear to be correlated with selection for food, which seems to consist principally of globigerinae and copepods, which are doubtless restrained from escape, with the water ejected from the mouth, by the structures functioning as pockets and whalebone.

Another paper, largely based on the work of the Albatross, was that of Dr. Gill on the ichthyological peculiarities of the Bassalian realm, as he has proposed to call the deep-sea region. His views, which are at direct variance from those of Dr. Günther, based on the study of the Challenger material, will be given in some detail in an early number of *Science*.

In his paper on mastodons, read by Dr. Gill, Prof. E. D. Cope claimed that ten species were known from North America, of which no less than eight flourished during the Puerco period.

Dr. J. S. Billings, through Major Powell, suggested a new method of studying crania by means of composite photography, and exhibited some very interesting prints taken in illustration, on each of which seven adults of the same race and sex were shown from in front, in profile, and from beneath. Sioux, Eskimo, and Hawaiian-Islanders were the races chosen; and the method seemed capable of wide application with good results.

President E. M. Gallaudet read a paper on the 'combined system' of teaching the deaf, which he illustrated by one of his pupils, who could answer questions put to him with considerable distinctness. The speaker was not, however, of opinion that the use of the manual system could be entirely dispensed with, and characterized as a fallacy the views supposed to be held by another school, — that because some deaf had been taught to speak by lip instruction, therefore all could be so taught. The system which Dr. Gallaudet prefers, he would probably consider an eclectic one, applying to each case the method best adapted to it.

The following gentlemen were elected members of the academy: Profs. E. S. Dana and Sydney I. Smith of Yale college, Gen. C. B. Comstock of the corps of engineers, Dr. W. K. Brooks of Johns Hopkins university, and Capt. C. E. Dutton of the U. S. geological survey.

The autumn session of the academy will be held in October, at Newport, R.I.

AN ARCTIC VESSEL AND HER EQUIPMENT.

A GOOD portion of the science of navigation is devoted to the subject of safety. In navigation in the ice, that object is increased tenfold in importance, and overshadows all others. In the history of the different arctic voyages, whether for popular reading or for scientific report, this question of safety has generally been considered only so far as that particular voyage had any thing interesting or useful to suggest as a result of its own adventures. While it is not hoped in this article to add any thing to our previous stock of knowledge, still it is possible, that by bringing together a statement of various dangers and difficulties to be met, and the methods which have been employed to overcome them, its publication will aid in an understanding of this often talked of arctic voyaging.

The subject of ice-navigation embraces the construction of ships for this peculiar employment, or the altering for it of those that have seen less severe service; their management under the various combinations of ice-packs, ice-floes, icebergs, tides, storms, currents, and every obstacle of the frigid zone; their care and preservation in the ice during the arctic winter; and their liberation from this ice when the summer will allow them to begin again their experience as they prosecute their journey on or homewards.

I will not dwell upon such indubitable facts as the quality of the ship's material, which it is evident must be of the very best, be it wood or iron, or the almost equally apparent fact of the superiority of a vessel specially constructed for this purpose, by the hands of proper persons who have had experience in arctic navigation as well as naval construction, over the reconstructed merchantman or even stronger built man-of-war. The superiority of iron ships over those of wood no longer holds in the Arctic. The rapid conductive power of the former makes it almost impossible to keep an equable temperature without a thick inside coating of some non-conductor, besides the more rapid formation of frosts from condensed moistures along the outer sides of the bunks, causing serious diseases, and greatly aiding the propagation of that most terrible of all arctic scourges, the scurvy. The superior strength and endurance of iron over wood, in the usual accidents of the temperate and tropical seas, seem to be lost when the test comes in the shape of severe pressure from the ice; the elasticity of the wood allowing it to return to its original shape after an almost indefinite

number of nippings which are not sufficient to directly crush the vessel, while the same number of equal pressures on its iron companion become slowly accumulative, until it finally succumbs.

A wooden vessel, however, may be very properly plated with iron over the hull for some feet under water, to protect it from the grinding action of the 'ice-tongues,' which are formed by the unequal melting of the edges of large ice-cakes, which, projecting their huge submerged points often for a distance of twenty or thirty feet, become dangerous to a vessel compelled to thread narrow and tortuous channels and 'leads' in an open field of pack-ice, where the first intimation of their presence is a low, dull, groaning sound, and a swinging of the ship, probably a half-dozen points, despite the helmsman, or probably a perfect arrest as the helpless ship comes up broadside against the cake of ice, and with all sails thrown aback. 'Ice-tongues' which gradually shoal from a greater depth than that drawn by the vessel are not so dangerous as those not so deep, the latter acting like a ram in a collision. In case of a 'nip' or a pressure from ice on both sides, these same ice-tongues are to be earnestly prayed for, as their shoaling sides often aid a vessel in being lifted out of the water, when, in such a tremendous pressure, she could be saved in no other way. Therefore, when a 'nip' is inevitable in a narrow 'lead' constantly closing down on a vessel, this fact should be strongly borne in mind in selecting that point where the least damage will probably be done when the final collision comes. It would appear, therefore, that iron ships are inferior to their weaker but more elastic wooden compeers; and this is ably demonstrated by facts in the sad fate of the River Tay in 1868, in Baffin's Bay, and of the Swedish exploring-ship Sophia, in the north of Spitzbergen. In both instances these vessels sank under circumstances where good wooden vessels would probably have survived.

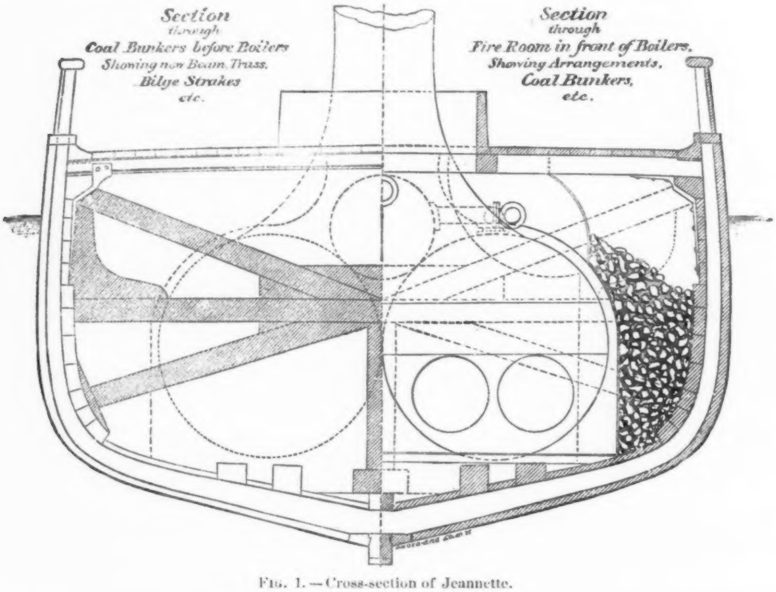


FIG. 1.—Cross-section of Jeannette.

I believe the limited experience with iron rigging in the arctic regions has been against it, except on short summer cruises with no intention of wintering. However, it is not a subject of much importance, unless the sails be alone depended on.

Coppering is of little or no use, and I have not been able to find any comments upon it by those who have used it. In such cases it was probably a part of the sheathing before the vessels were intended for arctic duty, as on the Erebus and Terror. The fact that most vessels are sheathed with two or three inches

of planking in their vulnerable parts for ice-navigation, makes the ordinary metal sheathing of but little importance. This wooden sheathing varies considerably in arctic vessels as to the parts of the ships that are plated, the thickness and amount, and kinds of hard or soft wood planking.

Having decided to build a wooden vessel, the shape of the hull is not a matter of indifference. The full, round ship, or, nautically speaking, a ship with full lines, is much more liable to be crushed by ice-pressure than one built with sharp lines; as fully illustrated in Koldeway's German expedition, when the Germania, built upon the latter principle, stood the ice-nip without very serious consequences during a heavy storm, while her companion the Hansa was crushed and sunk, she being modelled upon the former plan; and this, despite the fact that the Germania was the larger vessel, and therefore more liable to destruction than her lighter escort. This was also said to be the fault with the Jeannette, whose cross-section is shown in fig. 1, taken from Mrs. De Long's 'The voyage of the Jeannette.' Nothing less than an 'ice-tongue,' whose submerged edge would be below the point braced by the inclined beam at its foot, would have been of much use to save her in a 'nip' by the method of lifting already noticed.

These 'ice-tongues' are very much less frequent than most people might suppose from the constant use of the expression in this article. They are really very rare; at least, of such shape and size as those indicated. The edges of an ice-cake or an ice-floe may be of any shape consistent with unequal melting of its parts, and the 'tongue' is only one of the rare varieties. If very acute, it may be too weak to wedge up a boat, and may break off, as I saw in one instance, which, luckily, was not caused by a 'nip,' or the ship would have been immediately crushed. It is upon the relative position of these inequalities of the ice-edge fore and aft of a ship, that depends whether or not she will inevitably be crushed when two cakes or floes come together at her position during a heavy ice-pressure: therefore, the larger the ice-cakes in a pack, the better is her chance of escape.

The ease with which a ship can be lifted is, of course, a direct function of her size and weight. The size for an arctic exploring-vessel may vary, depending upon the service to which she may be put, and the time she is to be employed in polar seas; still, the general principle that a vessel should be as small as possible, compatible with the object in view, is a good one. The smaller and lighter the boat, the more easily is she raised by the squeezing floes; and the cases where this lifting of a vessel from the glacial vice, in one or two instances completely from her element, has been the salvation of her, are sufficiently numerous to be taken into account. Again: a small ship is more readily handled in the tortuous channels through which she is often compelled to thread her way while working in floes just sufficiently open to allow progress.

While arctic authorities agree upon the employment of small ships, the exact size in tons is seldom stated; but, in the few cases mentioned, about four hundred tons may be taken as the maximum limit. The superiority that a large vessel has over a smaller one in its greater momentum, when called upon to 'ram' the ice, so as to force a passage, is compensated by the fact, which experience has fully settled, that the large ship will succumb sooner to these severe and repeated shocks that she is thus compelled to bear. It should be added, that it is only when the floes are small, and the ice comparatively loose, that any ship, whatever may be her size, can 'ram' it with any fair prospect of effecting a passage. A steamer intended for 'ramming' the ice is always strengthened at the bows by 'dead-

FIG. 2.—'Deadwood' backing for bows.

wood,' or a solid wood backing (Fig. 2) not unlike that given to trial-targets for ordnance practice in solidity and strength. The depth of this may reach as much as twenty feet, although I have only heard of and never seen such depth. It may be cut off abruptly perpendicular to the keel (*a*), or given a parabolic flare (*b*), which, for the same amount of wood, is evidently the stronger for the various strains that the bow of an ice-vessel may be called upon to bear.

With a vessel thus provided, sometimes a triangular indentation of a thin floe may be 'rammed,' and the ice split by the wedge, the vessel burying herself in the crack; and then, when there is a large crew, their running in a body from port to starboard, and reverse, by rocking the vessel, has been known to increase the new 'lead,' and allow the vessel to back

out for further operations. When the wind is blowing vigorously, there are some disadvantages in 'ramming,' besides the condition of the pack caused by it. A vessel with the wind on the beam, and standing high out of water, and with considerable sailing-gear aloft, drifts faster than the pack, and, in backing out for a fresh start, may find the ice in the rear interfering with her backward movements; for a propeller must be very careful in all her retrograde actions.

This charging, 'ramming,' or pushing of ice by a vessel brings us to a consideration of the motive power most serviceable for ice-navigation, — steam or sails; for it is only by the former that charging can be made possible, except in those extremely attenuated packs where the headway of the sailing-craft is sufficient to carry her safely through, should she be compelled to strike a few glancing blows on isolated cakes. The use of steam may be laid down to be all-important, despite the fact that some few persons of no inconsiderable experience as arctic navigators still denounce the waste of room occupied by the steaming-machinery; the necessarily large amount of fuel to make it effective; and the anxiety imposed upon the commander regarding his propeller, which may break its blades, despite its protection of iron grating, and other derangements of machinery, that may here become extremely difficult, if not impossible, to repair. The first attempt to use steam in ice-navigation was with a paddle-wheel steamer, in 1829; and, as would be expected, it was the most worthless when the most needed. The propeller was first used on Sir John Franklin's ill-fated expedition in the Erebus and Terror, in 1845. It was worked by locomotive machinery; and how well it did its work, like a great deal of other information concerning that party, is wrapped in mystery. Certain it is, Sir John Franklin came nearer accomplishing his object than any of his predecessors; but whether due to his propellers, or to a favorable season, can only rest on conjecture. However, his propellers were not powerful enough to release him from his two-years' besetment in the ice-packs of Victoria Straits, unless the cause was due to a scarcity of coal.

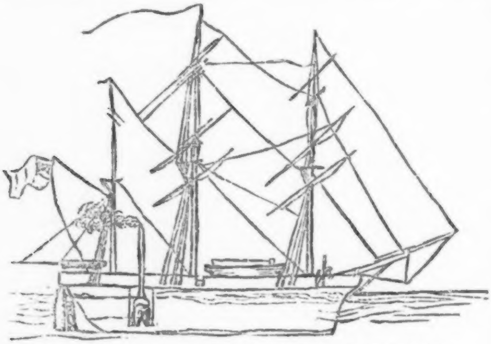


FIG. 3. — Sketch showing engines in Sir John Franklin's ships.

With the various improvements in propellers, especially in their protection by iron gratings and baskets, came their more universal use in arctic navigation; and at this date one seldom hears of an expedition to these waters not thoroughly fitted with this most essential auxiliary to a perfect success. By steam-power only can a vessel defy the ever variable winds of those regions. The Mallory propeller, or some modification of that form, will, I think, be found useful in threading narrow lanes through ice-packs. Certain it is that there is no place in the annals of navigation where a vessel is called upon to constantly make such short turns in such limited space as in ice-navigation. Of the steam-winch placed on the Jeannette's deck forward of the smoke-stack, capable of lifting the screw, unshipping the rudder, and warping the ship ahead, De Long's journal says, "Our steam-winch did good service, for we could easily snub the ship's head into a weak place when we did not have room to turn her with the helm."

Running before a breeze and with a current is said to be the most favorable condition that can be secured for a sailing-craft, more on account of the disjointed and open condition of the ice-pack that is usually produced by this state of affairs than the speed, which should always be lowered, sailer or steamer, if there is any danger of unnecessary collision with the ice. Even in this most favorable state, if she be running towards the throat of a funnel-shaped channel, she will more than probably encounter a gorged ice-pack at this point, barring her farther progress. A sailing-vessel caught in this predicament is in a very precarious condition. To the well-known obstacles of returning against wind and current, there is superadded the incoming ice, which will certainly add one or two, if not two or three, points to her leeway, in constantly attempting to weather the large ice-cakes and often equally dense and larger ice-packs with fruitless results. The time lost in wearing her around, or throwing her on the other tack when a channel, open one min-

ute, has closed in her front, makes it almost and often quite impossible to return: and the grinding, crushing pack soon builds up to her position, and encloses her under the most dangerous circumstances that can occur in ice-pressure, unless she can find an 'ice-dock' like that described by Dr. Kane; and even this, at any minute, is liable to be obliterated by an increase of wind, or a pressure due to the accumulation of ice or change of tide. This state of affairs is, I think, more than probably illustrated in the case of the besetment of Sir John Franklin's Erebus and Terror, in September, 1846, off Cape Felix, on King William's Land. Attempting to pass through Victoria Channel, whose southward-trending current is at this point greatly narrowed by the converging shores of Victoria Land on the west, and those of North Somerset, Boothia, and King William's Land on the east, his propellers worthless or his coal-supply short, either he must have encountered this ice-gorge so late in the year that his ships were almost immediately frozen in, or the summer's winds held him against or in the pack, as already indicated. The latter idea seems to me very reasonable; for during the time my party was on King William's Land, from the time the ice broke up in Victoria Channel on July 24, 1879, until the ice, newly forming, was sufficiently thick to stop a sailing-vessel (which was about the middle or latter part of September), I was forced to notice an almost continuous north-north-west veering to north-east wind, evidently caused by the warm rays of the almost never-setting summer's sun heating and rarifying the atmosphere over the vast snowless plains of upper British America, whose place is filled by the denser air chilled by the great ice-fields of the Arctic Ocean. That this Victoria Channel is navigable under very favorable and exceptional circumstances is shown by the fact that one of these two ships afterwards floated down or sailed through this narrow strait to near the mainland of America, some one hundred and fifty miles, manned by not more than four or five men.

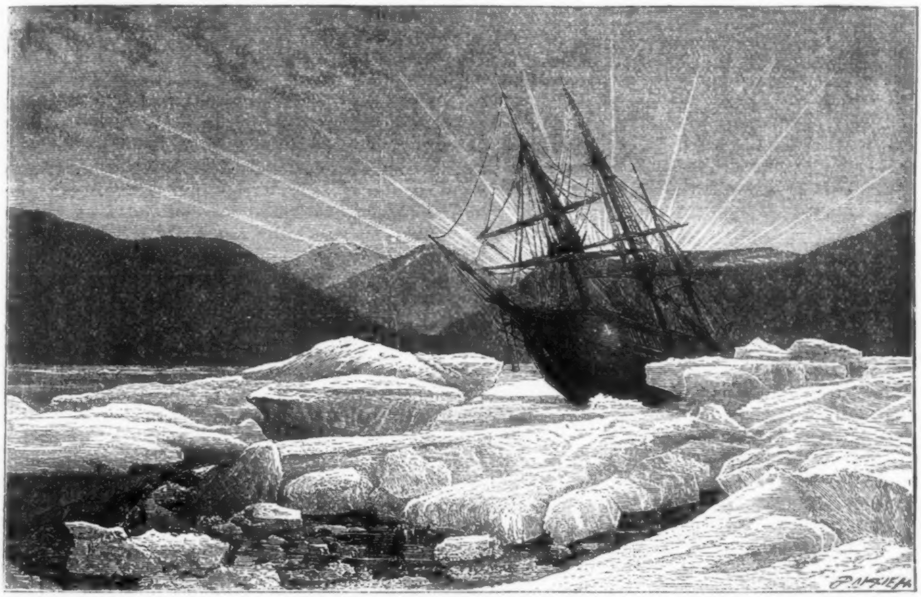


Fig. 4. — H.M.S. Alert forced on the land.

A steam-vessel can go into winter harbor much later than one with sails alone; and this is of no small importance, considering the short season during which navigation is at all practicable. This arises mostly from her superior advantages in 'charging' the newly forming ice of the early fall. The action of a sailing-vessel in this kind of ice is so well described by Sir Edward Parry, who had seen

five arctic expeditions, all in sailing-craft, that I transcribe his short description: —

"The formation of young ice upon the surface of the water is the circumstance which most decidedly begins to put a stop to the navigation of these seas, and warns the seaman that his season of active operations is nearly at an end. It is indeed scarcely possible to conceive the degree of hindrance occasioned by this impediment, trifling as it always appears before it is encountered. When the sheet has acquired a thickness of about half an inch, and is of considerable extent, a ship is liable to be stopped by it unless favored by a strong and free wind; and even when still retaining her way through the water at the rate of a mile an hour, her course is not always under the control of the helmsman, though assisted by the nicest attention to the action of the sails, but depends upon some accidental increase or decrease in the thickness of the sheet of ice, with which one bow or the other comes in contact. Nor is it possible in this situation for the boats to render their usual assistance by running out lines or otherwise; for, once having entered the young ice, they can only be propelled slowly through it by digging the oars and boat-hooks through it, at the same time breaking it across the bows, and by rolling the boat from side to side. After continuing this laborious work for some time with little good effect, and considerable damage to the planks and oars, a boat is often obliged to return the same way that she came, backing out in the canal thus formed to no purpose."

A sailing-vessel caught in this unfortunate state of the ice must immediately seek winter quarters in the nearest harbor; and if that be remote, and the wind unfavorable, or, rather, unless it be extremely favorable, the crews will be forced to cut a channel the entire distance for the helpless ship. This Parry was forced to do in 1819, near Melville Island, the channel cut being nearly three miles long. On the contrary, with steam-power, ice only half an inch thick is an insignificant obstacle; and a vessel thus equipped can steadily force her way through such a thin sheet, while even that proportion of a yard can easily be overcome by charging, requiring only well-strengthened bows.

Although good arctic authority has said that "the making fast to a floe should never be attempted except when every hope of navigating in the surrounding waters has been fruitless," and further adds, "As a principle, and so far as it is possible without the exhaustion of her powers, a ship in the ice should endeavor to be in constant motion, even though this entail many changes of her course and the temporary return to a position which had been abandoned" (Payer), still the latter suggestion, involving, as it may, for a great period of time, the consumption of coal, and the many cases where vessels with banked fires have with advantage fastened to floes with their ice-anchors, ready to escape almost at a moment's notice, makes these bits of advice not strictly essential for steamers, if they be properly harbored under the lee of the ice. With a sailing-vessel, this recourse becomes much more dangerous. The fastening to an iceberg is not altogether unattended with danger, and should only be resorted to when other means of safety are remote. The Polaris was justified, in such an instance, in seizing on to Providence Berg, although I have seen some contrary opinions expressed. A sailing-vessel should only do this when it becomes necessary to avoid drifting into a more perilous position.

Another advantage of steam over sail power alone is in the case of a calm with a strong tidal or other current setting towards an ice-pack or stranded iceberg, in waters so deep that anchors are of no avail; the salvation of the latter from possible severe injuries depending upon the relative power of the current, and the strength exerted by her small boats to tow her off, while the easy escape of the former is obvious. Also, in the early and late navigation of these waters, the sails are liable to become completely clogged with ice and sleet, rendering them, in extreme cases, impossible of manipulation. This state of affairs nearly proved fatal to the Griper (Capt. Lyon, R.N.) in September, 1824, in North Hudson's Bay, while attempting to battle with a terrible two-days' storm; the sleet forming over a foot thick on her decks, and proportionally over other parts of the vessel.

I should not have entered into so long a discussion on the seemingly palpable superiority of steam-power over that of sails, were it not for the fact that such a great proportion of the arctic expeditions are of a private nature, wherein the means of the liberal donor or donors cannot reach the increased expense of steam-machinery, fuel, and its accompanying charges; and those serving are willing to accept the situation rather than compromise the expedition altogether. There are also a few, as I have already hinted, who are opposed to steam-power from the great room it sacrifices, and its liability to incur greater risks than it can escape from if at all unfortunate. There is also a medium class, who, acknowledging the waste of room as the only detriment to be found in steam, believe that this power should be represented by machinery of the cheapest class, which can be abandoned and its room made useful at any time that it fails to subserve some good purpose.

It may be laid down as a good rule, that all sailing-vessels should have some 'square' rig to subserve active movements in the ice. Sailer or steamer, the pipes for pumping should be much more capacious than usual, and there

should be a system of them reaching to every part of the vessel; for the pumps may be needed the most when the vessel is careened on her beam, or at some unusual angle fore and aft.

If possible, a tender should accompany the exploring-vessel proper, especially if she be a steamer, whose stores of coal and other articles are to be transferred when the ice becomes dangerous for such a craft, presumably not strengthened to combat with that element.

Frederick Schwatka.

ON THE FUNDAMENTAL THEORY OF DYNAMIC GEOLOGY.

Many lines of inductive research lead to the conclusion that the interior of the earth is in a fluid condition, and that the solid shell is comparatively very thin, but variable in its thickness from district to district, and in the same district from time to time geologically. A crust twenty-five miles in thickness at a maximum, and very much thinner at a minimum, best explains geologic phenomena. If we consider this crust to be made up of units defined at the upper surface by districts of some magnitude, it seems necessary to regard it as existing in a state of floating equilibrium; so that, if some portion of the rocky material is taken from any such district, it rises, and the district on which it is deposited subsides. In case material is transferred for a very short distance, appreciable displacement may not result, the local structural rigidity being sufficient to withstand, or largely withstand, the stress. But if the short transferrence is across the line of a fault, from the upraised to the thrown side, the facts seem to show that the upheaved side continues to rise by reason of unloading, and the thrown side to subside by reason of increased load.

The rigidity of the crust of the earth arising from the molecular cohesion of the solid state is greatly modified by mechanical structure. The crust is composed of geologic formations of diverse origin, diversely arranged. The formations are broken into great blocks by great fault and flexure planes, in many cases doubtless extending quite through the crust. It is also fractured in multitudinous ways, and the crevices filled with vein matter. Again: each block or segment of a faulted formation is divided into small fragments by stratum planes, joints, schist planes, and slaty cleavage. The rigidity of each minute fragment is due to the molecular cohesion of solidity, but the general rigidity of the crust is dependent on mechanical structure. The fragments of which the crust of the earth is composed are exceedingly minute when compared with geologic formations, and they appear relatively as but grains of sand when compared with the whole crust of the earth.

This fragmental character of the crust is exhibited at the surface, and to the greatest depths to which observation has extended; and, so far as it depends upon the great faults, it must extend quite through the crust. There may be and probably is a zone beneath, so nearly fluid by reason of temperature and pressure, that fractures are less easily generated and more easily repaired, but the rigidity of the crust is not increased thereby.

The solidity of the crust of the earth is limited by temperature and pressure under conditions of chemical constitution and hydration, and is further limited by the conditions of its mechanical structure.

If vertical stress be applied to a point on the surface of the earth, the strain is propagated laterally by the condition of rigidity, but not indefinitely, as this rigidity speedily vanishes in the presence of the enormous forces involved in the weight of the crust itself, and in the great bodies of matter that are unloaded and loaded at the surface. The distance to which the strain extends is greatly lessened by the fact that the crust is not a continuous solid by cohesion, but preserves continuous rigidity in a very imperfect way by mechanical structure alone.

If the crust of the earth were practically homogeneous in the specific gravity of its materials, its static equilibrium would not permit the existence of any great elevations at the surface; but to the conclusion of a general equilibrium, geologists and geodesists are alike converging; and, if true, it necessitates the further conclusion that the crust, and perhaps to some extent the underlying fluid matter, is of varying density from region to region. This conclusion follows from a consideration of the inequalities of altitude existing in the earth's surface: and, since they are ever changing from district to district, — as one subsides and another rises, — contraction and expansion must occur. The necessity for the hypothesis of contraction and expansion is not obviated by the hypothesis of a fluid interior, nor is the latter rendered unnecessary by the former.

There is a constant lateral transferrence of material at the surface by rains, rivers, and marine currents; there is a constant vertical transferrence of material by displacement; there is a constant transferrence of material

from beneath to the surface by extravasation; and geologists postulate a constant transferrence of material beneath by subterranean flow, thus completing the cycle of transferrences.

But transferrence of material laterally and vertically does not serve completely to explain all the history of geologic movement. Another hypothesis is yet necessary; and this exists in the postulate of ever-changing density, arising from the following sources: first, changes in density due to chemical action, especially as exhibited in hydration; second, changes in density due to solidification from the melted state, and to liquefaction from the solid state; third, changes in density due to pressure and to relief from pressure. A consideration of many geologic facts has suggested to the writer that it may be possible, that, when the rigidity of the solid state is overcome by pressure, the rate of condensation due to added pressure is increased at that critical point; or, stated in another way, that the passage of rocks from the fluid state induced by pressure, to the solid state by relief from pressure, is marked by a sudden expansion. Should experiments hereafter give warrant to this conjecture, the chain of conditions necessary to the explanation of dynamic geology would seem to be complete.

Early in the history of geologic research, a contraction of the earth, due to the loss of heat, was postulated to explain the deformations of the crust. This loss of heat occurs in two ways, — by conduction, and by convection from the interior to the surface. The convection is accomplished by the heating of subterranean waters, and their escape as hot water and steam from the multitudinous hot-springs and geysers of the world, by the steam discharged in large quantities from volcanoes, and by the lavas which come to the surface to be cooled. By this method of convection, cooling progresses at a high rate; for the lavas even of quaternary times are of vast extent, and the lavas of all geologic history are correspondingly vast in amount. How cooling by convection is quantitatively related to cooling by conduction cannot be stated with our present knowledge; but, when all of this cooling is considered, the rate of condensation is insufficient to explain the known displacement — it is necessary to resort to other agencies.

For the fundamental theory of geologic dynamics we have as conditions, first, a fluid interior of great specific gravity, in part due to compression; second, a solid crust of irregular thickness, not continuous by molecular cohesion, but composed of small fragments mechanically arranged, and permeated by water from above; and, third, an aqueous fluid and an atmospheric gas in motion over the crust.

The agencies of change may be considered as primary and secondary. The primary agencies are, first, general secular cooling by conduction and convection; second, the heat of the sun setting in motion the air and water at the surface; third, the astronomic agencies that produce stresses. The secondary agencies are, first, local heating and local cooling; second, local loading and unloading, having an augmented effect at the critical point of solidity; third, chemical reactions arising from changes of temperature, pressure, and hydration; fourth, the expansion of water into steam by internal and local heating.

The changes wrought are, first, general secular contraction; second, transferrence of material horizontally at the surface by aqueous agencies, and in the interior of the earth by flow, and vertically by subsidence and upheaval, and from within to the surface by extravasation; third, change in the chemical and lithical constitution of rocks, as seen in various forms of metamorphism; fourth, local lateral compression of formations, exhibited in plication and implication, and local stretching, exhibited in certain parts of flexures.

Conjointly and severally, the conditions, agencies, and changes thus enumerated seem to furnish a fundamental geologic theory, in harmony with and explanatory of the multifarious facts discovered in geologic research. Geologists widely accept the several parts of the theory save one; namely, that which assumes that the solid state is a critical condition of volume. The general theory enunciated is modified by a multiplicity of minor conditions, agencies, and changes, to expound which a voluminous treatise on geology would be necessary.

The correlation and interdependence discovered to exist between volcanism, seismism, displacement, surface degradation, sedimentation, and metamorphism, furnish important evidence in favor of the general theory. So far as research has progressed, regions of great and frequent displacement are found to be regions of great degradation and sedimentation, of great extravasation and seismism, and of great metamorphism; while regions of small displacement are regions of small degradation and sedimentation, of small extravasation and seismism, and, so far as known, of small metamorphism. The evidences of correlation are exhibited in many and diverse ways.

The agencies of change enumerated in the above theory are interdependent, so that the

increase or diminution of one results in the increase or diminution of all. If the agencies of the first order — i.e., secular cooling, heating of the sun, and astronomic stresses — be neglected, the other agencies are interdependent in such a manner that there is a tendency secularly to establish an equilibrium; and doubtless such an equilibrium would be established in a period not of great length considered geologically. But the agencies of the first order continuously destroy the static equilibrium, and, conjoined with the others, they produce the sequence of changes discovered in geologic history.

The rate of internal cooling is manifestly diminishing, and physicists incline to the opinion that the heating due to the sun is diminishing. From this stand-point, then, the rate of change in geologic history is secularly diminishing. On the other hand, the secondary agencies of change increase in efficiency by reason of increased heterogeneity in the structure of the crust. From the irregularities of the upper surface, and those probably existing at the lower, as suggested by many facts, the crust is heterogeneous in thickness, and doubtless is becoming more so. It also becomes more and more heterogeneous in constitution by the progressing differentiation of its parts, exhibited in the diversification of geologic formations, density, temperature, conductivity, hydration, and chemical and lithical constitution. This internal heterogeneity renders the crust more sensitive to external agencies of change, so that a smaller amount of primary change serves to unlock a given amount of secondary change. At the present stage of geologic research the facts are not sufficient to establish the quantitative relation between the diminished rate of change from the primary agencies and the increased rate of change from the secondary agencies. It is therefore impossible to predicate any variation in the rate of change from the close of archaean time to the present.

J. W. POWELL.

EVOLUTION OF THE DECAPOD ZOEA.

PRINCIPLES applicable to adults are often equally applicable to larvae. In the discussion of natural selection most writers have confined themselves to adult animals and their reaction upon environment. There is no reason, however, why the principle should not be extended to include larval forms; and, indeed, to a slight extent this has already been done. Weismann's 'Theory of descent' proceeds upon this line, and indicates some of the important results which may arise from such research. Crustacean larvae offer particularly good opportunity for work in this direction. They are abundant, are easily obtained, and readily studied. They present great varieties of form, which are frequently not in any degree related to the adult characteristics. Indeed, crustacean larvae seem almost like a distinct group of animals, and may be studied as such, with the extra advantage that they are highly variable, and undergo rapid metamorphosis. Some of the possibilities of such research may be seen by a short consideration of the different forms of decapod zoea.

To make the subject clear, it will be necessary to give a brief description of three types of decapod larvae, confining ourselves, however, only to such points as particularly concern us here. The first is the type, which is undoubtedly the oldest, known as the protozoea. It is a comparatively rare form, being found in a few macruran species (Peneus, Lucifer, Euphausia). Fig. 1 represents such a larva. As far as concerns us, the peculiarities are these: the long body consists of a large cephalothorax, a more or less complete thorax, and an abdomen. The important point is, that all of the regions of the body are represented. When viewed from above, the part of the body composed of thorax and abdomen is seen to be very slender and weak, and to extend for a long distance backwards. A second important point is the method of locomotion: unlike all other forms, the antennae, instead of being sensory organs, are used in locomotion. They are large, and covered with swimming-hairs, which convert them into paddles; and, by moving them to and fro, the protozoea slowly propels itself by a series of jerks through the water. The telson is a third important feature: it is small, being in our figure no broader than the abdomen; it is usually forked, and carries a number of long spines (typically seven, though the number varies); it is not a swimming-organ, — a point of particular interest. One other feature must be mentioned, — the usual though not universal absence of protective spines.

A second type is that of the ordinary macruran zoea; e.g., the larva of the common shrimp. Such a zoea is represented in fig. 2. Here we find a number of changes. First we see that only two regions of the body are present, the cephalothorax and the abdomen, the thorax being unrepresented. The cephalothorax is not very different from that of the protozoea. The abdomen is, however, very different: it is distinctly divided into segments, all of which are well developed; it is tolerably thick, and is a much more powerful structure than the corresponding part of the protozoea. The muscular and usually the nervous system is well developed. In short, the abdomen is much more perfect than that of fig. 1. The locomotion of this zoea is entirely different from that of the protozoea. It does not use its antennae for moving, but propels itself vigorously with powerful strokes of its abdomen, after the manner of the lobster: at least, this is its motion when trying to escape danger; and that is all that concerns us. In correlation with this changed locomotion, the antennae have altered their form, and are now true sense-organs. On the other hand, the telson has become broadened into a flat

swimming-organ. It is much broader than the rest of the abdomen, and is used as a paddle to augment the effects of the powerful strokes of the abdomen.

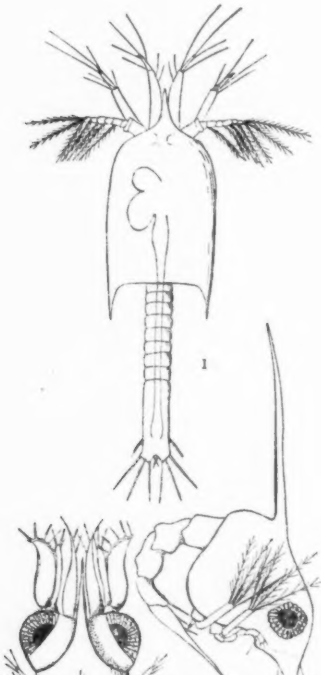


FIG. 1.—Protozoea of Lucifer (after Brooks). FIG. 2.—Zoea of Gebixl. FIG. 3.—Zoea of Panopeus. FIG. 4.—Telson of Panopeus zoea.

It still retains a number of spines, but they are usually quite small.

A third type is the zoea of the ordinary crab. Fig. 3 is such a zoea. Here we see a number of striking peculiarities. As in the shrimp zoea, we find no middle body; i.e., the thorax is absent. The abdomen is quite small, and always occupies a characteristic position. Instead of being stretched out behind the body, as in the shrimp zoea, it is bent under the cephalothorax, as in the figure. Still another mode of locomotion is here found. It is true that occasionally it uses its tail; but its ordinary locomotion is neither with antennae nor abdomen, but by means of its first two pairs of maxillipeds. These are very long, and carry large numbers of swimming-hairs, and serve as oars, with which the zoea paddles itself along. Its motion, while swifter than that of the protozoea, is not so vigorous as that of the shrimp. The tail has become modified into a form halfway between the tails of the other two larvae described. It is somewhat broadened, and probably has a slight motor function; but its chief use is protection (fig. 4). The most noticeable feature is the very remarkable cephalothorax. This is of enormous comparative size, entirely covering the body when the abdomen is flexed. It is further armed with a number (usually four) of long spines, which project in different directions, and are strong and sharp. No one can be in doubt as to the use of this arrangement. The large cephalothorax, with its resisting spines, serves as a protective case for the more delicate organs within; and, further, when the abdomen is flexed, the spines of the peculiar telson are placed in such a position as to give additional protection, being then directed forwards.

Now, is there any connection between these three forms, and is it possible to discover any explanation for their peculiarities? In the first place, comparative embryology shows good reasons for believing that the first type, protozoea, is the oldest, and that the others are derived from this form. The evidence cannot be here deduced, but may be found by referring to Claus, Brooks, or Balfour. Assuming, then, this to be the case, the question resolves itself into the simpler one, what caused the protozoea to undergo changes which converted it into the remarkable zoea form?

A simple experiment, easily performed by any one at the seashore, suggests an answer. The experiment is simply to endeavor to catch a specimen of each of these types of larvae with a moderately small dipping-tube. It will be noticed that all of the larvae seem to have a dread of the suction which is produced by the tube; and all will swim away from it, unless it be too strong. It will be further seen that it is next to impossible to catch the shrimp zoea. He darts away with the vigorous strokes of his tail, and, unless the fisherman is very quick, he is gone. Some of the crab zoeas will be easily caught; but they will be seen, upon examination, to have doubled themselves up into as compact a mass as possible, with all their spines projecting, and consequently in position to offer the greatest defence against enemies. Other crab zoeas will be found not so easily caught. If the zoea fished for be of the species figured, or, still better, be the larva of Porcellana, and the dipping-tube be small, it will be found impossible to catch it. The long spines project so far in different directions, that the

larva cannot enter the tube. Finally the protozoea will be easily caught: it swims slowly, and cannot escape the tube; nor does it present projecting spines which prevent its entrance into a small orifice.

This simple experiment teaches us four things: 1°. The dread of suction exhibited by all forms indicates that their chief enemies are small animals, largely, perhaps, fishes which swallow them in their widely-opened mouth; 2°. The behavior of the macruran zoea shows evidently, that, in its struggle for existence, it relies for its protection upon its power of flight, and this gives us immediately a hint as to the meaning of the broad tail; 3°. The crab zoeas rely for their protection, not upon flight, but upon the efficacy of their defensive armor, either as an actual defence, whose resistance baffles the jaws of the fish, or as an apparatus which prevents their entering the mouth of a small enemy (this consideration immediately explains the use of the excessively long spines in Panopeus and Porcellana, which seem to be such encumbrances to the freedom of the larva); 4°. The protozoea seems to possess none of these means for protection; and, indeed, in every respect the protozoea seems ill protected. Its slow, hesitating motion, its long weak abdomen, its long antennae with their numerous swimming-hairs, — all render it easily entangled by rubbish, and easily caught by any enemy.

Taking all of these points into consideration, we get suggestions as to a possible explanation of the remarkable differences between the crab and the shrimp zoea, — differences which seem difficult to understand, since the Brachyura and Macrura are evidently so nearly related. All decapod larvae are freely swimming animals, gaining their own living by an active search for food: they are therefore subjected to a struggle for existence precisely similar to that of adult animals. The principle of natural selection will be as potent to select and modify them as it is in selecting and modifying adults. If, therefore, we assume the protozoea as an original form, we must expect to find it in many cases highly modified, and must expect in most larvae to find, not a protozoea, but a greatly different form, and one better adapted for the struggle for existence. Nor must we be surprised if the embryologist comes to the conclusion that the modified larval stages do not represent stages of ancestral history.

That the protozoea larva is not well adapted for a struggle with numerous enemies is evident to any one who observes how easily it is captured. Assuming that this is the early larval form, we should not expect, from what we know of the workings of nature, that such an evidently weak form would be preserved, except in isolated cases. To adapt such a larva to a more effective struggle, there are three methods: the larvae may be largely increased in numbers, which would, of course, increase the chance of the species for survival; or they may develop powers of flight, which will enable them to escape their enemies; or the larvae may develop some sort of defensive armor, which will enable them passively to resist all ordinary attacks. Abundant examples of each of these methods may be found in almost any group of the animal kingdom, but probably no better instances than the larvae in question; and this is all the more interesting, since it shows that some of the principles affecting adults also in a similar way have their influence on larvae. With these points in mind, it is possible to explain all of the important differences between the protozoea and the two zoea types.

What explanation can we find for the shortened body? Two explanations for this can be found, both of which probably had their influence. The possession of such a long, weak, almost functionless hind-body as is found in the protozoea is certainly calculated to render its possessor a more easy prey to enemies than it would be were the body more compact. The shortening may therefore be simply a protective measure. Or a second principle has probably had even more influence. There is good reason for believing that the amount of energy of a developing animal is limited, and, if expended in one direction, cannot be employed in a second. If, for example, a child over-develops its brain, its body is sure to suffer. Now, this principle has had a similar effect in our larvae. In the protozoea the energy of development is evenly distributed to all parts of the body. The result is, that we find here a larva with almost all of the body present, but in a low state of development: the larva is consequently comparatively weak. If, however, the development of a part of the body should be postponed, the parts which did develop could reach a greater state of perfection, since the whole energy of development could be directly turned toward their perfection. In all existing zoeas the development of the thorax has been thus postponed. The zoeas are found, therefore, to be much more vigorous than the protozoeas, their muscular and nervous system is better developed, and they are in all respects more fitted for an active struggle for existence; and this applies equally well to the macruran or the crab zoea, and will assist in accounting for the absence of a thorax in the two forms, — a point which seemed a great difficulty to Balfour.

In other respects the crab and the shrimp zoea have taken two different lines. The macruran type has become modified for its struggle by acquiring great powers of flight: we find its body, therefore, long and slim; but, unlike the protozoea, it is very powerful, has well-developed muscles, and a broad, paddle-like tail, which, with the assistance of the powerful abdomen, forms an effective organ of flight. Every thing which might impede its motion has disappeared. The antennae are small, and the other appendages are such as to present no hinderances. The whole body has become adapted to its swift motion.

On the other hand, the crab zoea has taken a different line, and has developed, instead of a power of flight, a defensive armor. Its cephalothorax has enlarged, has become strong, and has developed a number of defensive spines, whose use has already been noticed. Its tail, not particularly needed for swimming, has not developed into a broad plate, but has become an augmentation of the defensive armor by the form and position of its spines. Some species have carried this line of development still farther,

and are provided with enormously long spines, many times the length of the body, which effectually prevent their being swallowed by small animals. The development of the spinous protection would seem to be correlated with the absence of a swimming-tail. Some species (Pinnotheres, Tatuira) which do not possess any of these spines show a tendency toward a modification of the telson, which has in these cases become quite broad and flat.

We may assume, then, that at one time the decapods, or the stem from which they arose, universally possessed a larval stage somewhat similar to the form known as a protozoea. As the struggle for existence became more and more severe among the Crustacea, modifications arose which took two directions. The adults became changed; and there arose in this way the different types which we know as Anomura, Brachyura, and Macrura. But at the same time natural selection had its influence upon the free larvae quite independent of its influence upon the adult. The larvae, therefore, also became slowly modified for their own protection; and from the protozoea arose the zoea types, with their infinite variety. It is quite evident that these changes may take place in the larvae without materially affecting the adult, for the circumstances bringing them about influence the larvae alone. Still it is probable that habits and form of the adult may have some influence upon the general shape of the larvae. The larva must eventually transform itself into the adult; and the more nearly it approaches the adult form, the less radical will be the change. We can therefore understand why the zoea of the walking animal, such as the crab, would develop protective apparatus, while the zoea of the rapidly-swimming Macrura would acquire organs of flight. We have therefore an explanation of the two facts, that the larvae of the greater groups exhibit a certain unity, while within a given genus the different species may widely vary. H. W. CONN.

THE EXPLOSIONS ON THE UNDERGROUND RAILWAYS OF LONDON.

THE explosion of Feb. 25, at the Victoria station, London, lends interest to the official report of Col. Majendie, on the results of an investigation of the circumstances attending the explosion near the Praed Street station, on the 30th of October last, and the one between Charing Cross and Westminster stations. The first explosion occurred in a tunnel about a hundred and thirty-eight feet distant from the station, as the 7.52 P.M. train was passing. The damage in the tunnel consisted of a vertical crater in the wall about twelve by thirteen inches, and four to six inches deep. Immediately below this crater, and extending about fifteen inches along the wall, was a horizontal crater about six inches deep, partly in the ballast, and partly in the brick footing of the tunnel. The flinty ballast in this crater was considerably splintered, and the brick footing pulverized. A two-inch iron gas-pipe ran along the wall at a height of ten inches. A length of this, measuring fourteen feet, was blown away, one end being much torn and twisted, and the whole piece bent into the form of a bow. At a distance of fifteen inches from the wall, and parallel with it, was an iron switch-rod, consisting of an inch and a quarter gas-pipe, supported on iron rollers at the level of the rails, from which it was distant two feet nine inches, the rollers being fixed on a wooden plank laid on the ballast. This board had about four feet of its length blown to splinters, and a large piece thrown upon the rail, and some of the wheels of the train passed over it. A length of the switch-rod measuring about two feet, and corresponding exactly with the portion of the gas-pipe which sustained the maximum injury, was blown out, the central part of this detached portion being split up and torn. This piece of switch-rod also bore marks of the wheels upon it. A telegraph cable, running along the wall at the height of eight feet and a half, was cut by the explosion. The walls of the tunnel were scored somewhat by the sharp *débris* blown against them, and the end of a sleeper opposite the crater, but partially protected by the ballast in which it was embedded, had a number of pieces of splintered stone driven deeply into it. The rails were entirely uninjured.

The injury to the passing train was confined principally to the last two carriages of the six composing the train. In these the greater part of the glass was broken into small fragments. Panels and partitions were shattered, the roofs and floors disturbed, the foot-boards broken, and the carriages seemed to be completely wrecked, yet no part of the framing or running-gear was injured. The gas throughout the train was extinguished, yet the apparatus was found to be uninjured. It is interesting to note, that the injury to the train was not confined to the side upon which the explosion took place, but extended also to the opposite side; and in the case of one carriage the damage was most marked on that side. Sixty-two persons were injured by cuts and contusions from the pieces of glass and *débris*, and, in one or two cases, by fracture of the drum of the ear and by severe shocks. Five of the injured were confined in the hospital for a considerable time. The breaking of the glass and putting out of the gas occurred on the surface, at the openings of the tunnel, for a distance of three hundred and fifty feet.

The second explosion, which occurred almost simultaneously with the first, took place at a point two hundred and forty-one yards from Charing Cross, and four hundred and eighty-eight yards from Westminster. As it occurred opposite a bay, the only damage done was the breaking of glass, and the extinction of the gas in both stations; the injuring of the telegraph and telephone wires for about sixty yards; the formation of a crater in the ballast, measuring about three by four inches, and one inch deep; and the 'pitting' of the walls of the tunnel, on the side of the explosion for some little distance to the right and left of the crater, and on the opposite side for a somewhat greater distance. The rails were entirely uninjured; but the ends of two sleepers, close to the point where the explosion occurred, sustained some injury.

Three hypotheses were suggested as to the nature of the explosive; viz., coal-gas, gunpowder, and dynamite. The fact that all the gas apparatus was found intact disposed of the first. The absence of all residue, and the extremely local and brusque action of the explosive, testified unmistakably to the use of an agent possessing greater detonative energy than gunpowder, while these properties are characteristic of dynamite. The finding of a piece of Bickford safety-fuze and fragments of copper, presumably from a detonator, strengthened this belief. Accepting this theory, experiments were made by Col. Majendie, together with Professor Abel and Dr. Dupré, to determine the amount of dynamite necessary to produce the observed effects, the switch-rod and gas-pipe from the Praed Street tunnel being used in similar positions to the charge which they bore there; and it was found that two pounds of ordinary dynamite would be sufficient, if properly detonated. The circumstances surrounding the explosions, however, indicated that a larger amount — probably five pounds — had been used, but that a portion had burned without explosion.

The means used for inducing the explosion was probably a suitable fuze of such a length as would burn for the desired time. This was then attached to a detonating-cap, and the latter inserted in a zinc case containing the dynamite. The assassin then boarded a passing train, and, lighting the fuze, threw the contrivance from the window, the fuze being timed to explode the cartridge under the train following. In the case of the Praed Street train the explosion was premature, and exploded under the train in which the assassin was. In the second case the explosion occurred at the time designed, but the train for which it was intended was late. In one minute more the train would have reached the spot, and the result would have been more serious.

UNIFICATION OF TIME.

A part of the minutes of the session of the International geodetic association held in Rome last October, embracing the resolutions and discussions concerning an international prime meridian and system of expressing time, has been published. The resolutions have already appeared, but the discussions are now made public. Delegates were present from Bavaria, Belgium, France, Italy, Holland, Norway, Austria, Prussia, Roumania, Russia, Switzerland, Spain, United States, and Great Britain, and the almanacs were represented by Foerster, Loewy, and Pujazon.

The French delegates alone seemed to be somewhat opposed to the project; and their arguments, singularly enough, were not altogether unlike those that are so commonly urged against the adoption of the metrical system of weights and measures in this country.

Mr. Faye admitted the 'practical and undeniable need of a universal system of time;' but he would regret to see the suppression of all the nautical almanacs except that of England as a result of adopting the meridian of Greenwich, because 'these publications fed the sacred fire of astronomy.' "Still," said he, "the French government may be found more accessible to the proposal, if it be brought to the conviction that the reform would be advantageous from the point of view of general civilization;" which we may interpret as meaning, "if England will adopt the metric system in return." Professor Foerster thought it a strange phenomenon to see scientific men more narrowly nationalistic upon scientific questions than the nations and governments themselves. He considered it wicked to multiply repetitions of substantially the same calculations of ephemerides in the different countries merely to 'feed the sacred flame of astronomy;' or, in other words, to find support for computers.

Col. Perrier urged that the adoption of a distant meridian would be found extremely inconvenient in topographical maps; but Dr. Hirsch replied, that the meridian of Greenwich would hardly be more unfavorable than that of Paris for the eastern parts of France; and Helmholtz pointed out, that Germany, which had during a long period used the meridian of Ferro, had experienced no inconvenience from its being so distant.

Mr. Yvon Villarceau held, that any reform of the system of reckoning longitudes and time should be accompanied by a decimal division of the circle and of the day. But the idea of sweeping away the division of the day into twenty-four hours met with no favor; though the conference consented to a resolution expressing the 'incontestible advantages of a decimal division,' not of the circle, but of the 'quadrant of the circle, in extensive calculations.'

Mr. Loewy, the director of the *Connaissance des temps*, was more decidedly hostile to the change than any other delegate. He thought its advantages slight, its inconveniences considerable; and he could not consent to changing the usage of centuries in the arrangement of an ephemeris, without the most conclusive reasons. Professor Foerster in reply, holding the *Connaissance des temps* for 1884 in his hand, showed the great simplifications which would result from the change, and added, that Loewy himself had, in his direction of that ephemeris, been one of the most radical of innovators, and had certainly modified the arrangement far more than the proposed reform would do.

Notwithstanding the objections of the French members, some of whom voted against single resolutions, when the question was put, whether the body of resolutions should be adopted as a whole, it was carried unanimously, Loewy alone not voting. A very gratifying degree of accord may therefore be said to have been reached. Mr. Christie, the astronomer royal, declared his personal sympathy with the resolution expressing the hope that Great Britain might enter into the metre treaty, while explaining that he was not authorized by his government to encourage that hope. After the adoption of the resolutions, Gen. Cutts, the delegate of the coast survey and of the American government, which, it will be remem-

bered, has invited a diplomatic conference to be held in Washington upon this subject next year, addressed the meeting as follows: —

"Now that the important questions submitted to our deliberations have received, as I hope, their final solution, and that an agreement due to the merit of the cause has been reached, I ought, before the convention separates, to declare that the government and the learned societies of the United States are inspired in this matter, as almost all my eminent colleagues are aware, first, with the necessity of the change, and secondly, and more especially, with the desire of favoring the interests of science as well as those of commerce by land and sea.

"On the one hand, the civil day, as it now exists, has been preserved; on the other, for scientific and commercial reasons of high importance, a prime meridian and a zero of time, applicable to all nations, have been introduced. These decisions open a new era, which will be more and more appreciated, as the progress of nations, of international relations, and of science, — which knows no latitude nor longitude, — shall bring to light, in their assured development, all the advantages of the new system.

"About ten days ago the great railway-companies of the United States and Canada, operating 161,000 kilometres of lines, adopted the Greenwich meridian as the origin of time. I consequently think that I may express the hope that all the governments represented at the seventh conference of the Geodetic association will accept, on the recommendation of this conference, the invitation of the United States to send delegates to the international congress which is to be held next year at Washington, with the effect of resolving the question of the unification of longitudes and of time, and probably of proclaiming the great reform as an accomplished fact."

The mode of reckoning time proposed by the Geodetic association is substantially to use Greenwich mean solar time with the astronomical day. This is, perhaps, not absolutely inconsistent with the continuance of the system now in use in this country, of using Greenwich minutes and seconds with the most convenient hour, — a plan substantially the same as that first propounded by Professor Benjamin Peirce at the very beginning of the agitation for a new system. The geodetic congress assures us, that while there is nothing impractical in Greenwich time, pure and simple, the adoption of the time of the nearest whole hour from Greenwich is absolutely out of the question, because it would force people to get up and go to bed at unseemly or inconvenient hours. Indeed, their language would seem to imply that apparent as distinguished from mean time is imperatively required. "We do not, of course, wish," they say, "to suppress local time in common life, for that is necessarily and absolutely ruled by the *apparent* course of the sun: we do not dream of forcing the population of certain countries to rise at noon, nor of forcing others to dine at midnight." For people accustomed to regulate their actions by the striking of the church-clock, the change of time is certainly something more than a mere turning-round of the dial of the time-piece; and the European populations do go by the striking of bells much more than ours, no doubt. Nevertheless, the coming congress must be impressed by the eagerness with which our new system has been almost univefsally adopted, and even forced by the people upon the authorities. It is, perhaps, not surprising that it has been the scientific men, the theoretical men, who have been the last to judge the change to be practicable.

THE ORGANISMS OF THE AIR.

Les organismes vivants de l'atmosphère. Par M. P. MIGUEL, chef du service micrographique à l'observatoire de Montsouris. Paris, *Gauthier-Villars*, 1883. 8 + 310 p. 8°.

So much that has been written on the subject of the bacteria is merely a recapitulation of what has already been done, or a presentation of results based upon insufficient observations, that it is a pleasure to find a work filled with careful investigations carried out on an extensive scale.

The book before us contains no new or startling discoveries, but rather gives an almost mathematical proof of certain generally received ideas on the distribution of the microbia, and serves conclusively to refute certain errors which have been widely accepted.

The facts have been obtained by a daily analysis of the air taken in the Parc de Montsouris, near Paris. For the sake of comparison, air has also been taken from the centre of the city, the hospitals, and sewers.

After a brief historical sketch of the subject, comes a description of the organic and inorganic particles which have been deposited from the air, and which can be distinguished by aid of the microscope. Among the most interesting of the inorganic constituents are minute fragments of meteoric iron, which can be collected by passing a magnet over the dust, and of which Mr. Tissandier has made a special study. From the organic world are found vessels and bits of plants, as well as the cast-off shells of infusoria and their eggs, as proved by cultivation.

In order to study the particles suspended in the air itself, they must first be collected by aspirating a given quantity over a thin glass covered with glycerine, and then carefully examining the deposit. The cells thus obtained can be roughly divided, for purposes of classification, into four classes: —

1. Grains of starch.
2. Inert pollen of phanerogams, and the zoospores of unknown algae and cryptogams.
3. Spores of cryptogams and zoospores capable of producing a perfectly determinate alga, lichen, or other fungus.
4. Entire vegetables, usually unicellular plants, among which are to be noticed the green algae, the conidia, the yeasts, the *débris* of confervoids, diatoms, etc.

The starch comes mostly from the manufactures, but also from natural sources.

The pollen is never found germinating in the

air, however humid this may be. It is most abundant in spring and summer, and almost disappears during the autumn and winter. During the summer it exists to the number of from five thousand to ten thousand in every cubic metre of the atmosphere.

The spores of the cryptogams and algae appear during the damp months of April and May, and reach their greatest numbers in the latter part of June. They persist during the summer, and fall off during the autumn, to become as rare in winter as the pollen. The number varies from seven thousand in a cubic metre in December, to thirty-five thousand in summer. Fluctuations are found dependent upon damp or dry weather, the action of which, however, differs with the time of year. During a cold and wet period in winter, the spores sink to their minimum, while during the dry time the air is greatly enriched, but chiefly by old spores. In the summer, on the contrary, during damp days, the fructifications of the cryptogams are everywhere distributed in abundance.

"The average of the spores collected by the aeroscope is about fourteen thousand per cubic metre. These figures are not excessive, and it is to be hoped that they will settle the contradictory opinions in this regard which have been expressed during the past twenty years. They will go to confirm in their ideas the partisans of the germ-theory, and will show to the few defenders of spontaneous generation how useless it is to invoke the doctrine of heterogenesis to explain the appearance of the mucidines in the liquids and on the substances fitted to maintain their life."

From an etiological and hygienic point of view, it does not seem that such diverse spores, introduced into the economy at the rate of thirty thousand a day, or one hundred million a year, are absolutely innocuous. The development of soor in the mouths of infants and in the respiratory tract of the dying show that the fungi also belong to parasites ready to invade the human organism when there is presented a point of feeble resistance.

The analysis of the air taken from the sewers showed about the same amount of organized material, with the exception of the almost entire absence of starch.

The remainder of the book is devoted to a study of the bacteria present in the air. This is the part which will naturally be of the greatest interest, from the relations which these minute organisms bear to disease and to the processes of putrefaction and fermentation.

Chapter iii. is devoted to a statement of the experiments of Pasteur and others, proving conclusively the existence of germs in the air, which alone are responsible for changes in the liquids into which they fall, and thus setting at rest the question of 'spontaneous generation.'

The classification of the bacteria receives a valuable contribution as the result of long and carefully conducted experiments. The author is convinced of the immutability of the species, but shows that they are capable of great variations under different conditions, and that without great watchfulness 'species' can be easily multiplied. The genera which are usually recognized, and which he accepts, are Micrococcus, Bacterium, Bacillus, Vibrio, and spiral Microbia. Even these genera cannot always be distinguished apart with certainty by their form alone. The characters which serve to differentiate them are briefly as follows: Micrococci and Bacteria never produce spores, Bacilli do; Micrococci are immovable, Bacteria are movable; Vibrios and Spirilla have an undulated or twisted form.

The methods of obtaining the spores from the air, and the sterilization and preparation of the liquids proper for their development, are the subject of the next chapter. This, as all other parts of the work, shows the results of infinite care and patience. National prejudice is, perhaps, the reason why the solidified meat-extracts and blood-serum have not been employed for the cultivation of the spores. But it is perhaps fortunate for the progress of science that such prejudices exist, as each method is developed to its greatest extent, and the exact value of the one can be controlled by the other. The liquid nutritive material has certainly received a most thorough trial in the hands of Mr. Miguel, and the results obtained by its use are not to be thrown lightly to one side. There are infinite sources of error when experimenting with the 'infinitely small;' and the precautions which have been found necessary from these extended observations should caution those observers who have only limited means at their command against hasty generalization. One of the most important safeguards is the proper 'firing' of the flasks which are to receive the culture. Experience has shown that they should be heated during four hours at 200° C.; and then, after having been charged with the 'bouillon,' they should stand for two months at 35° C. in a constant temperature apparatus. At the end of that time those which have retained their limpidity are regarded as sterile, and ready to be sown.

In order to obtain the number of spores distributed in the atmosphere, equal amounts of air are drawn over these sterilized solutions, and are then allowed to germinate at a constant

temperature of 35° C. If five or six groups of experiments are made in the same day and place, the results are almost identical, provided that the force and direction of the wind are constant, and, above all, if the air has not been purified by rain or snow. From this, the equal distribution of spores is proved, and not that they are in so-called 'clouds,' as has been maintained by Tyndall.

Signs of germination may appear within twenty-four hours; but it is usually from the second to fourth day that the greatest number of flasks are altered. From this time there is a rapid decrease until the thirtieth day, after which any alteration rarely takes place. The growth is manifest to the unaided eye in three different ways: —

1°. The liquid preserves its clearness, but a more or less voluminous deposit occurs at the lower part.

2°. The liquid is uniformly clouded at first, and then a veil arises, or a deposit is formed.

3°. The liquid remains transparent, but little isolated white clouds of silky mycelium appear, which can invade the entire fluid. These are usually fungous growths, but there are several filamentous microbia which can give rise to the same appearance.

In the flasks which are altered by these aerian spores, there rarely is perceived that nauseating cadaveric odor of intense putrefaction, produced by inoculating a drop of water from a sewer or even from the Seine. The bacteria of the air are only feeble and superficial putrefactors, and rarely cause a profound decomposition of the liquids into which they are introduced. It is necessary to banish from the mind the idea that we live literally besieged by organisms always ready to sow putrefaction on the mucous tract of our economies. The inhabitants of the country, more privileged in this respect than the dwellers in the city, hardly introduce into their lungs, in the course of a day, one germ of putrid fermentation.

The degree of alterability of the nutritive liquid should always be taken into account in experiments; and numerous investigations were made on this point. From these it appeared that an infusion of hay was the least susceptible of alteration, while neutral beef-bouillon, with the addition of one per cent of salt, was the most so. Normal urine held a middle place. These had been sterilized by boiling for two hours at 110° C. Contrary to general expectation, egg-albumen, diluted with water and sterilized by filtration through plaster, was found to be almost as resistant as the infusion of hay.

In order to cultivate the bacteria in a state of purity, a drop of one cultivation is transferred to another sterilized flask on the point of a 'fired' platinum needle. The danger of infection from the air, during the time the flasks are opened to permit the transfer, is very much less than is generally supposed. By computation, the chances are only as 1 to 1,500.

The results of the daily examination of the air at Montsouris during three years showed that bacteria and their spores were more abundant during hot weather than cool, and were inversely proportional to the degree of moisture. The direction of the wind was also of consequence, that which had traversed Paris being richer than that coming from over the country.

In respect to the seasons, the greatest number of germs were found during the autumn, then followed summer and spring, and lastly came winter, as the following table shows: —

Autumn,	121	spores per cubic metre of air.
Summer,	92	" " " " " "
Spring,	73	" " " " " "
Winter,	53	" " " " " "
Or a mean of	84	" " " " " "

The germs which thus find their way into the air are either carried there when dry, or are taken up with fine particles of water by the wind: they never pass off with the insensible evaporation of a fluid. A series of ingenious experiments with the condensations from putrefying liquids and substances proved the truth of this assertion.

The comparative analysis of the air taken from the streets near the centre of Paris showed that it was nine or ten times richer in schizophytes than that from the Montsouris Park.

In regard to the relation of the bacteria in the air, and the occurrence of epidemics of disease, the fact was observed, that, at the time when there was a comparative increase of deaths from zymotic disease, there was an unusually large number of germs in the air. As it is impossible at present to distinguish harmless from pathogenic microbia, and as the inoculation of cultures from atmospheric spores gave nearly negative results, the author wisely does not lay great stress upon this coincidence.

The interiors of houses were next made the subject of investigation. It was found, that, in a room which was perfectly still and undisturbed, there were 27 microbia to the cubic metre, against 97 in the air outside. The number in the same space in the author's laboratory was found to be 215 in 1880, 348 in 1881, and 550 in 1882. In an ordinary bed-chamber

in Paris, regarded as sufficiently clean, there was found, in the spring of 1882, 3,830, and, in the winter of 1882, 6,500; giving a mean of 5,260 to the cubic metre. A comparison with the air of a room used for a study in the observatory at Montsouris showed, for the spring of 1882, 270, and, for the winter of 1882, 380; giving a mean of 325 to the cubic metre. From this it at once appears that the air of the house in Paris was sixteen times as impure as that at Montsouris. The decrease in the number of germs from winter to spring is the reverse of what is observed out of doors, and is to be attributed to the more thorough ventilation during the warm months.

The same relation was found in the air from hospitals, except that the numbers were very much higher; varying from 4,500 in summer, to 24,000 in winter, per cubic metre. The micrococci were found to be most abundant here; every hundred germs furnishing, on an average, ninety-one against five bacteria and four bacilli. The inoculation of these, however, was without result.

The air and water from the sewers gave interesting results. A cubic metre of the former furnished from 800 to 900 microbes, while a litre of water taken at the point where it was discharged gave 80,000,000. In this relation it was found that a litre of water condensed from the atmosphere held about 900, a litre of rain-water 64,000, a litre of the Seine at Bercy 4,800,000, while, after the river had traversed Paris, a litre was found to contain 12,800,000. From this it can be understood how easily stagnant water of a sewer can putrefy, and how essential it is that there should always be a current flowing to prevent this. In the air of sewers it is the bacteria proper which abound, but they were without effect when inoculated in animals.

In the ordinary dust of houses it was estimated, after careful weighing and cultivation, that each gram contains about 750,000 spores. A sufficient number of analyses of the soil have not been made as yet, but those made give an average of from 800,000 to 1,000,000 for each gram of earth. In the deeper layers the bacilli preponderate over all other forms, while on the surface the micrococci are most abundant.

Antiseptic substances are last considered; and these are regarded as acting in two ways, — first by destroying the bacteria already in activity, and, secondly, by preventing the germination of spores.

Of such substances, oxygenated water (H_2O_2) was found to be the most powerful, then solution of corrosive sublimate and nitrate of silver. After these come a long list of less efficacious ones. The only compounds which were capable of destroying germs in their dry state by means of the vapor given off were bromine, chlorine, hydrochloric and hyponitric acids.

Such is a brief summary of the principal points touched upon in this book. It is not quite so clearly and concisely written as might be wished; but it is a valuable contribution to science, and must serve as a model for any one who undertakes work in this direction. A careful perusal of the book itself is certainly to be recommended to all interested in the subject.

MINOR BOOK NOTICES.

Outlines of chemistry for agricultural colleges, public and private schools, and individual learners. By N. B. WEBSTER. New York, *Clark & Maynard*, 1883. (Practical science series.) 8+144 p. 24°.

THIS book seems somewhat out of place in a practical series, inasmuch as it consists chiefly of a collection of definitions and brief statements of common facts.

The experimental side of the subject is almost wholly neglected, or, at best, is passed over with brief allusions. To the student who is receiving instruction by lectures, the work might be of some service as a partial relief in taking notes, or as a book of reference, though it is too limited in detail to be of general use in this direction; but, as a text-book in a systematic course of instruction in elementary chemistry, it must fall short of the author's intention.

The electric light in our homes. By ROBERT HAMMOND. New York, *Worthington*, 1884. 12 + 188 p., illustr. 8°.

THIS is a special pleading for the incandescent electric light, delivered by Mr. Hammond in the towns of England as he travelled, in the hope of awakening the English people to the fearful condition of their homes at present, on account of the harmful effects of the products of gas consumption. In the opening, Mr. Hammond is very careful to first heat his audience over the gas-burners, then drench them with the condensed steam, and finally sprinkle them here and there with little specks of soot. After bringing his hearers into this unpleasant condition, a bright, clean, and cool incandescent electric light is held before their eyes till they fully appreciate its beauties. A short return is made to the drenching and warming process to make sure of any laggards, and the conditions of success of an electric-light system are explained. The story is well told

throughout, if one does not object to the fact, evident on every page, that the author has something to sell.

Patents on inventions: a quarterly patent-law review. H. CONNETT and A. C. FRAZER, editors. Vol. i. New York, *Burke, Frazer, & Connett*, 1884. 12+214+12 p. 12°.

THIS is a collection of short essays on points of interest to inventors. These essays are principally written by the members of the firm of Burke, Frazer, & Connett, patent solicitors, in the intervals which their practice allowed. The articles are generally well written; but to some extent the smack of the advertisement clings to them, although none close with the advice to call on Messrs. Burke, Frazer, & Co., for a solution of the difficulties discussed. Throughout, the beauties of patents are upheld, and the *ignis fatuus* of a valuable patent is made as alluring as possible.

INTELLIGENCE FROM AMERICAN SCIENTIFIC STATIONS.

GOVERNMENT ORGANIZATIONS.

Geological survey.

Field-work in the division of the Pacific. — In addition to the office-work of this division, carried on during the winter at San Francisco, field-work has also been prosecuted, especially since the 1st of January. During February, Mr. George F. Becker, geologist in charge, studied the surface-geology of the area lying between Mount St. Helena and Knoxville, in Napa and Lake counties, Cal., — a region that had previously been mapped by Mr. Hoffmann, topographer, and in which Mr. Turner spent some time, especially in January of this year. The mines of this district have been made the especial subject of study by Mr. Becker; and they prove to be of very considerable interest, lying, as they do, between a highly metamorphic area and one of unaltered sedimentary rocks, which is also marked by limited basaltic eruptions. The structure of Mount St. Helena has also been partially examined. During January, also, Mr. Hoffmann's field-work for the map of the New Idria district was completed for the illustration of Mr. Becker's monograph on the quicksilver deposits.

Map of Mount Shasta. — Mr. Gilbert Thompson has just completed a sketch-map, on a large scale, of Mount Shasta. It includes about seventeen square miles, and shows beautifully the glaciers and moraines of the mountain. As already noted in *Science*, Mr. Thompson has recognized some seven glaciers on the upper slopes of Shasta. On this map five of them are named as follows: the 'Whitney' glacier is on the north-west side, lying to the eastward of the volcanic crater (Shastina) that forms so prominent a feature of the north-west spur as seen from the valley below. It extends two or three miles from the summit toward the north-west, with a width in most places of less than a quarter of a mile. This is the glacier seen and explored in 1870 by Mr. Clarence King. The next glacier, as one proceeds eastward, is the 'Bulam' (or great) glacier, which extends to the northward or north-westward about a mile and a half. It is nearly a half-mile in width, and at its head appears to be connected with the 'Hotlum' (or steep rock) glacier, which lies next to it on the north-east slope of the mountain. The latter is broad, being almost a mile across, and reaching only about a mile and a half from the summit. On the eastern side of the peak is the Win-tún glacier (so named from the tribal designation of the Indians of the vicinity). It is nearly two miles long, with an average width of about half a mile. On the south-east slope is the Kon-wa-ki-ton (or Mud Creek) glacier, which, until Mr. Thompson described it, was unknown, although many of those who have climbed the peak since 1854 must have passed close by it. It is smaller than the others, having a length of only a half-mile. Its width is about a quarter of a mile. Mr. Thompson has furnished very full notes of these glaciers to Mr. I. C. Russell, by whom they will be published in the reports of the survey.

On another map being prepared by Mr. Thompson, Mount Shasta and the surrounding country are shown on a smaller scale than in the above-mentioned map; and the isolation of Mount Shasta is well shown. It forms no part of any mountain range; and the highest land within a radius of forty-five miles from its summit is Mount Eddy, which is fifteen miles distant, and is at least six thousand feet lower.

Ice-banners. — In Tyndall's 'Forms of water' is an illustration representing what he terms 'cloud-banners,' which are formed by a current of warm air, charged with moisture, passing a high and sharp mountain point, when, meeting with a colder atmosphere, it is condensed, and forms a visible cloud, the appearance of which has some resemblance to a banner. On Oct. 18, 1882, Mr. Gilbert Thompson ascended Lassen's 'Butte' (or Peak), in California, which has an altitude of 10,500 feet above sea-level; and on Oct. 12, 1883, he made the ascent of Mount Shasta, which rises to the altitude of 14,511 feet, some seventy miles farther to the north-west. On the summits of these peaks, and on both occasions just after a storm, Mr. Thompson observed what he terms 'ice-banners.' The iron signal-post on Mount Shasta, which rises sixteen feet above the summit, had the appearance often seen in trees, posts, etc., after severe snow-storms, when the flying snow is impacted against them by the wind, except that in this case the projection was just reversed, and lay from the wind. On the signal-post the 'banner' projected

nearly four feet at the top, becoming narrower towards the base. Mr. Thompson has also observed the same phenomenon on sharp rocks and sticks. Ice-banners are evidently formed from the vapor of passing clouds; and an observer favorably situated might watch their formation and growth. He thinks that possibly the base of a cloud-banner might be found to be an ice-banner.

RECENT PROCEEDINGS OF SCIENTIFIC SOCIETIES.

American society of civil engineers.

April 16. — A paper was read by Hamilton Smith, jun., upon the temperature of water at various depths in lakes and oceans. The results of observations upon bodies of water in California, in the eastern states, and in Switzerland, were collated, and also the temperatures obtained in deep-sea soundings; all of which show that very slight variations in temperature occur at great depths, and also that great variations in surface-temperature affect the deeper waters only after a long interval, and that even in comparatively shallow reservoirs there is great uniformity in temperature, at even moderate depths, as compared with the variations in its surface.

Brookville society of natural history, Indiana.

April 8. — A. W. Butler presented a paper upon some explorations among the ruins of San Juan Teotihuacan, near the City of Mexico, illustrated by maps of that region, showing its topography. He described the appearance of the pyramids, the 'House of the sun,' and the 'House of the moon,' and gave the results of his investigations of the manner of their construction, and the excavations near them. A description of the so-called 'Micoatl,' 'Path of the dead,' and its relation to the 'House of the moon,' were given. In conclusion, he mentioned a large sacrificial stone found near the 'House of the moon,' which he illustrated by drawings of the front and top. —— Edward Hughes read a short paper upon the rats of Franklin county. —— A. W. Butler gave a short paper on the tornado of March 25, which he illustrated by maps, showing its course through the eastern part of Franklin county (Indiana), and the destruction it caused at Scipio, Ind.

Torrey botanical club, New York.

April 8. — Mr. Arthur Hollick read a paper upon autumn forms of the genus Viola. While engaged in studying the cleistogamous flowers of V. cucullata and V. sagittata, many other species were brought under notice, and important differences remarked in leaf, flower, and stem, which do not seem to have been previously reported. V. cucullata and V. sagittata are connected by every conceivable intermediate form of leaf variation and superficial characteristics, and V. palmata also connects with the former by insensible gradations. V. cucullata and its varieties are, however, distinguishable from either of the others mentioned by the decumbent habit of the cleistogamous flowers. In V. sagittata, on the other hand, the cleistogamous flowers are invariably erect. For some time it was difficult to know whether V. palmata was allied to V. cucullata or V. sagittata, but the appearance of the intermediate forms points to the former as the type. The three species of white violets — viz., V. blanda, V. primulaefolia, and V. lanceolata — are very closely allied, intermediate forms between the latter two being impossible to place accurately with either species. All three produce runners or stolons late in the season; but in V. blanda these runners are merely roots, being almost entirely under the surface of the ground, slender, and producing few or no leaves, and no cleistogamous flowers. The flowers grow from, or close to, the main rootstock, and are more or less decumbent. V. primulaefolia has the longest runners, some as much as twelve inches in length. They are comparatively stout, run along the surface of the ground, and are mostly leaf and flower bearing throughout. V. lanceolata will probably have to be referred to the same species as the latter. An important point to be noted is, that V. primulaefolia and V. lanceolata almost invariably grow in company with each other, while V. blanda generally occurs alone, and in different locations from the other two. These violets have three methods of propagation, — by petalous flowers in early spring, by apetalous flowers in the autumn, and by runners rooting at the nodes or joints. V. odorata produces both leafy runners and cleistogamous flowers; but the flowers are clustered around the main stem, instead of being on the runners. They are depressed upon short peduncles, and are sometimes almost subterranean. In V. canina, var. sylvestris, the cleistogamus flowers have peduncles not more than two inches long, generally less, while the others are from three to four inches in length. Also, while in the spring flowers only one starts from each axil, in the autumn forms there are usually two or more. V. pedata apparently never produces cleistogamous flowers, but very frequently blossoms a second time in the autumn. Specimens were collected as late as Nov. 5 in full bloom. —— A committee was appointed to prepare resolutions urging the necessity of legislative action in regard to the preservation of the Adirondack forests.

Colorado scientific society, Denver.

April 7. — The committee on artesian wells in the neighborhood of Denver made a preliminary report, outlining the basin within which the known flows might be obtained, and giving calculations as to the amount of water available. —— Mr. E. LeNeve Foster described a possibly new mineral from Mexico, having approximately the formula, $4\ Ag_2S\ .\ 6\ Pb\ S.\ 5\ Bi_2S_3$. It occurs as a massive cement to a granu-

lar mass of quartz, and may be a cosalite with about half its Pb replaced by Ag_2. —— Mr. A. H. Low described a new modification of the battery method for the estimation of copper, by which great accuracy in results is attained in from one to two hours. Substances which usually interfere with this process are either quickly removed, or their presence is rendered harmless by original methods. A full description of the process will soon appear.

Numismatic and antiquarian society, Philadelphia.

April 3. — Dr. Brinton spoke of some recent explorations made by him in the Trenton gravels, in search of the evidences of the existence of the palaeocystic man. —— Mr. Scott mentioned the fact that arrowheads had been found at Otaheite, apparently of human manufacture, but which, upon investigation, turned out to be made by the action of the sands of the seashore under the influence of the winds. —— Mr. Barber exhibited a copper currency used by the Haidah Indians. It was a thin plate of worked copper in the shape of an axe-head, with a hole at each end, and some remarkable groovings. Its value was estimated at two dollars. They range in size from one inch to two feet.

NOTES AND NEWS.

THE following is a complete list of the papers read at the meeting of the National academy of sciences, April 15–18: — G. K. Gilbert, The sufficiency of terrestrial rotation to deflect river-courses: T. Sterry Hunt, The origin of crystalline rocks: Simon Newcomb, On the photographs of the transit of Venus taken at the Lick observatory: A. E. Verrill, Zoölogical results of the deep-sea dredging expedition of the U. S. fish-commission steamer Albatross: Ira Remsen, The quantitative estimation of carbon in ordinary phosphorus; Reduction of halogen derivatives of carbon compounds: Elias Loomis, Reduction of barometric observations to sea-level: C. S. Peirce, The study of comparative biography: C. S. Peirce and (by invitation) J. Jastrow, Whether there is a minimum perceptible difference of sensation: S. P. Langley, The character of the heat radiated from the soil: J. E. Hilgard, On the depth of the western part of the Atlantic Ocean and Gulf of Mexico, with an exhibition of a relief model; On the relative levels of the western part of the Atlantic Ocean and Gulf of Mexico with respect to the Gulf Stream; Account of some recent pendulum experiments in different parts of the world, made in connection with the U. S. coast and geodetic survey: E. D. Cope, On the structure and affinities of Didymodus, a still living genus of sharks of the carboniferous period; On the North-American species of mastodon: Theo. Gill and (by invitation) John A. Ryder, The characteristics of the lyomerous fishes; On the classification of the apodal fishes: Theo. Gill, On the ichthyological peculiarities of the bassalian realm: George F. Barker, On the Fritts selenium cell; On a lantern voltmeter: George J. Brush, On the occurrence of mercury in native silver from Lake Superior: H. A. Rowland, Progress in making a new photograph of the spectrum: B. Silliman, On the existence of tin ore in the older rocks of the Blue Ridge: H. M. Paul (by invitation), The Krakatoa atmospheric waves, and the question of a connection between barometric pressure and atmospheric electricity: John S. Billings, Memorandum on composite photographs in craniology: A. W. Wright, Some experiments upon the spectra of oxygen: Elliott Coues, On the application of trinomial nomenclature to zoölogy: E. M. Gallaudet (by invitation), Some recent results of the oral and aural teaching of the deaf, under the combined system: F. W. Clarke, (by invitation), Jade implements from Alaska: Henry L. Abbot, Recent progress in electrical fuzes: J. S. Diller (by invitation), The volcanic sand which fell at Unalashka, Oct. 20, 1883, and some considerations concerning its composition. The following biographical notices of deceased members were also read: of Gen. G. K. Warren, by H. L. Abbot; of Professor Stephen Alexander, by C. A. Young; of Dr. J. Lawrence Smith, by B. Silliman; and of Dr. John L. LeConte, by S. H. Scudder.

— Tornado circular xxi., just issued by the signal-service, accompanies a second series of preliminary tornado-charts, showing the local storms of March 11, in their relation to broad cyclonic circulation of the same date. Eight tornado-tracks are mapped, — one in southern Illinois, one in central Kentucky, the rest in Mississippi and Alabama, — all occurring between two and seven in the afternoon. Their attitude with regard to the centre of low pressure is much the same as was shown for the tornadoes of Feb. 19. They are from seven hundred to a thousand miles south by east of the cyclone centre, within the area of warm southerly winds, and just east of the area of cool north-westerly winds; the two being separated by strong thermal gradients. There were five persons killed and fifty wounded by these tornadoes. The loss would have been much more severe, had not the people secreted themselves in cellars and 'dug-outs' on the approach of the storms. A more detailed study is promised at a later date.

— Dr. G. Stanley Hall, the well-known writer and lecturer on philosophical and educational subjects, has been appointed professor of psychology and pedagogics in the Johns Hopkins university. Dr. Hall was graduated at Williams college, and at a later day received the degree of doctor of philosophy from Harvard college, and afterward prosecuted his studies in Germany under Ludwig and Wundt. His lectures have been sought for in many colleges, and his co-operation in educational associations has been highly prized. He has written for the *Princeton review*, *Mind*, *The nation*, and other periodicals; and many of his papers were collected and published in a separate volume. He is now engaged in a prolonged inquiry respecting the education of young children, from which important results are anticipated. He is a man of unusual aptitude and training; and his friends believe that in the chair to which he is now appointed he will exercise a strong influence for good.

both in promoting the study of the mind, and in the training of young men to be teachers in colleges and high schools. He has also been deeply engaged in psycho-physic researches, soon to be published. Convenient rooms and suitable apparatus for this work have been provided by the university.

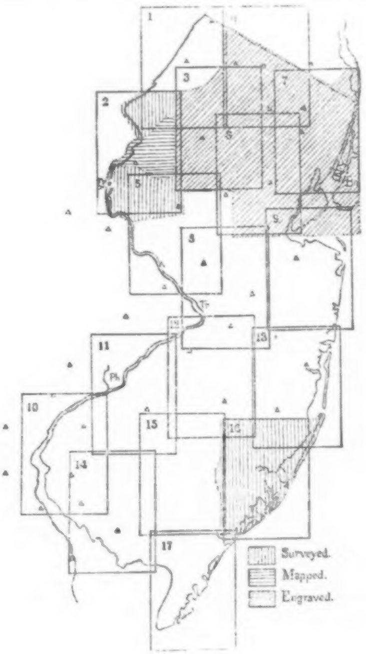
—Dr. William H. Welch, a graduate in arts of Yale college, and in medicine of the College of physicians and surgeons in New York, has been appointed professor of pathology in the medical faculty of the Johns Hopkins university. Dr. Welch is now pathologist to the Bellevue medical college in New York. He has given evidence of his ability as an independent investigator and as a skilful teacher; and, in connection with the Johns Hopkins hospital and university, he will have an excellent opportunity to advance the science to which he is devoted.

—Among recent contributions to invertebrate paleontology, we note Bulletin No. 2 of the Illinois state museum of natural history at Springfield, in which two new species of Crustacea, fifty-one of Mollusca, and three of Crinoidea from the carboniferous formation, are described by Prof. A. H. Worthen. Should the publication of a supplementary volume of the reports of the geological survey of the state be authorized by the legislature, the species now described will be fully illustrated. Meanwhile the typical specimens have been placed on exhibition in the state museum.

—A notice of some new species of primordial fossils in the collection of the American museum of natural history, New York, with remarks on species previously known, by Mr. R. P. Whitfield, appears in Bulletin No. 5 of the museum. These organisms are chiefly Brachiopoda and Crustacea, and are illustrated by two excellent plates.

—The recent geological work of the New Jersey survey has been chiefly in connection with the cretaceous formations, the artesian wells that they feed along the coast, and the crystalline rocks and their iron ores. The flowing well at Ocean Grove now yields a daily supply of sixty thousand gallons of sparkling, pure water, from a depth of about four hundred feet, or within twenty feet of the estimate, based on dip of strata, given by the survey in 1882. A second successful well has been lately bored in the same place. The drainage of the Great meadows, in Warren county, a work recommended by the survey, continues to show its efficiency: ordinary rains are quickly carried off; the autumnal and miasmatic diseases, formerly so much dreaded in its neighborhood, have disappeared; and the waste swamp-land, wherever brought into cultivation, shows a decided superiority over the surrounding high ground. Evidence is given to show the intrusive origin of the triassic trap-sheets of the Watchung (Newark) Mountains; and their crescentic outline is said to be "such as would be expected from a vertical force pressing against an inclined stratum of rock." Professor Newberry has nearly completed his monograph on the triassic fishes, and Professor Whitfield is at work on the invertebrate fossils of the New Jersey cretaceous.

—The annual report of the geological survey of New Jersey, by Professor George H. Cook, was recently published, and shows the same careful and successful administration of the survey that has been characteristic of it for several years past. In spite of the very limited cost,—"the expenses of the survey are kept strictly within the annual appropriation of $8,000,"—valuable and effective work is steadily accomplished. The most considerable undertaking at present is the topographical survey of the state, in charge of Mr. C. C. Vermeule. The primary stations, shown in the accompanying figure by a small triangle,



are provided by the U. S. coast-survey, and are now nearly completed. The plan of final publication of the state map in seventeen sheets is also shown. They will be on a scale of one inch to a mile, with contours every twenty feet in the hilly districts of the north, and every ten feet in the smoother country farther south. The surveys over the roughest and most difficult part of the state are now finished; and, although half the total area is not yet covered, it is said that more than half the labor is done. The state's area is estimated to be 7,576 square miles. Of this, 1,116 square miles were surveyed last year, giving a total of 2,856. 1,893 square miles have been mapped, and 1,691 engraved. When completed, there will be prepared, also, a general map, on a scale of five inches to a mile, of the whole state. This will be printed on a sheet twenty-four by thirty-four

inches, uniform with the seventeen others; and New Jersey will then have, beyond comparison, the finest map of any state in the country.

— Reports from Mount Hamilton, California, say that this has been the most stormy winter known since observations were begun at the Lick observatory. The bad weather did not begin till so late in January that a drought in California was feared; but there have been forty inches of rain and melted snow up to April 4, and at that date the mountain was covered with two feet of snow. The anemometer cups were blown away, with the wind-gauge indicating sixty-five miles per hour. The lowest temperature was $+12°$; and at this temperature outside, water did not freeze within the uncompleted buildings.

— A communication from A. W. Howitt of Gippsland, Victoria, states that he is engaged in preparing an account of the ceremonies practised by the Australian aborigines in the initiation of their youths to the privilege of manhood. He has recently had an opportunity of witnessing some of these ceremonies, never before practised in the presence of white men.

— Mr. J. Park Harrison writes to the editor of *The academy* concerning Saxon sun-dials, as follows: "The extreme rarity of Saxon sun-dials, or, perhaps, the paucity of dials that have been recognized as such, will render the discovery of an example in Daglingworth church, near Cirencester, of some interest to antiquaries. In this case there can be no doubt that the dial is coeval with the church, which has been pronounced by several of our best authorities to be Saxon. As in other equally early examples, the five principal hours are marked on the stone, and the dial is placed over the south doorway. At Daglingworth it has been well protected by a porch of somewhat later date. I hope that this notice may lead to a careful examination of the walls of other early churches."

— Jean Baptiste Dumas, the eminent French chemist, and leader of the French academy, died April 11, at the age of eighty-four. He was born at Alais, Gard. His early scientific education was in the study of pharmacy in his native village, and, later, in Geneva. At the age of twenty-one he found his way to Paris, where he continued to be prominent till the last year of his life.

— A paper on the structure and formation of coal, read by Mr. E. Wethered before the Geological society of London, March 5, is an attempt to show, 1°, that some coals are made up of spores, while others contain few or no spores, these variations often occurring in the different layers of the same seam or bed; 2°, that the so-called bituminous coals are largely made up of a brown amorphous substance, or bitumen, to the formation of which wood-tissue certainly contributed much more than spores. In an appendix to this paper, by Professor Harker, he refers the spores found in the coals to the modern genus Isoëtes, and suggests for them the generic title Isoëtoides. In the discussion, Mr. Carruthers dissented from the view that the coal-spores are related to Isoëtes, or any other form of submerged vegetation, believing them to belong to Sigillaria and Lepidodendron. Professor Dawkins agreed with Mr. Carruthers, and also followed Professor Huxley in holding that the resinous or bituminous portion of coal is chiefly due to the spores, and cannot be derived from woody tissue by ordinary process of decay. Similar views were expressed by Mr. Newton, Prof. T. Rupert Jones, and Mr. Bauerman.

— The members of the Scientific society of Indiana university are giving special attention to the local vertebrate fauna, and to the fishes recently collected at Havana and Key West, which are in the museum of the university.

— The *Engineer* for March 21 states that Cailletet, so well known in connection with the liquefaction of gases, has constructed an apparatus for the continuous production of intense cold, which consists of a closed steel cylinder containing a coil of copper pipe which projects from each end of the cylinder. Two copper tubes are also screwed into the cylinder; and one of these communicates with the mercurial piston-pump already used by Cailletet, while the other receives the ethylene which has been compressed by the pump, and cooled by methyl chlorate. By this arrangement he forms a circuit in which the same quantity of ethylene is repeatedly evaporated in the copper coil, producing intense cold, and then compressed again by the pump being sufficiently cooled with methyl chloride, and ready for evaporation again. This process goes on as long as the sucking and compressing pumps are working.

— The report of the English secretary of legation at Rome, concerning the new national library there, is given at length in the *Journal of the Society of arts* for March 21. The Italian government has taken over from the Jesuits the celebrated Collegio romano and its observatory. Various scientific societies have their rooms on the ground-floor. The first and second floors contain the ancient library, formerly in two divisions, one accessible only to the priests. A new hall has been built capable of containing 2,400 volumes, and a reading-room capable of holding two hundred persons. With the addition of the celebrated Casanatense, the richest ancient public library in Rome, the Victor Immanuel institute has space for 1,000,000 works. It seems as if the monks had made no additions to the library for nearly a century, and the first thing to which the resources of the library had to be applied was the purchase of modern classics, Shakspeare, Goethe, etc.: the collections Didot, Hachette, and Brockhaus have been purchased. From November, 1881, to November, 1882, there were 4,594 scientific works bought, while the government officials sent in 16,186 pamphlets and other documents. The library is open from nine o'clock until three, and in winter it is open in the evening from seven o'clock until ten.

— Dr. A. B. Griffiths, who has for some time been devoting his time to the study of the origin of petroleum, and advocates the organic view, writes to the *Chemical news* that he has found phenol in the stem,

leaves, and cones of Pinus sylvestris, — a discovery which he thus connects with the results of his investigations on the flora of the carboniferous period: "Taking into consideration the fact that solid paraffine is found in petroleum and is also found in coal, and from my own work, that phenol exists in Pinus sylvestris and has been found by others in coal which is produced by the decomposition of a flora containing numerous gigantic coniferae allied to Pinus, and that petroleum contains phenol, and each (i.e., petroleum and coal) contains a number of hydrocarbons common to both, I am inclined to think that the balance of evidence is in favor of the hypothesis that petroleum has been produced in nature from a vegetable source in the interior of the globe. Of course, there can be no practical or direct evidence as to the origin of petroleum: therefore 'theories are the only lights with which we can penetrate the obscurity of the unknown, and they are to be valued just as far as they illuminate our path.' In conclusion, I think that this is a connecting-link between the old pine and fir forests of by-gone ages, and the origin of petroleum in nature."

— The new English dictionary of the Philological society, edited by Dr. Murray, and pronounced by Mr. Furnivall to be the best dictionary of any language, has only reached the word ANT, and nobody knows when the end of the alphabet will come; but part i. gives a clear indication of the plan on which the work is to proceed, and shows that scholars in all departments, and not philologists alone, are to be benefited by its publication. Indeed, the construction of this dictionary has been governed by the scientific method. The authors began by observing and collecting facts, then proceeded to classify them, and then to ascertain what was taught by the facts. Three and a half million citations were made by thirteen hundred readers. Among the collaborators were many Americans, led by Prof. F. A. March. Rev. Dr. Pierson of Iowa sent sixty thousand quotations. From such resources, added to those already at command in Richardson, and other general dictionaries, and in the special glossaries of the Bible, Shakspeare, Milton, Pope, etc., it has been possible to determine the history of almost every word. It is curious to observe how sometimes the course has been upward from the language of common life to that of abstract philosophy; at other times the word goes down in respectability like a drunkard, and becomes positively vulgar. Indeed, the differentiation of words resembles the development of living beings: from very simple germs, very complex organisms are evolved. The 'form-history' of a word is what the editor calls its morphology, and includes a discussion of the derivation, phonetic changes, corruption, obsolescence, revival, etc.

In order to whet the appetite of those readers of *Science* who may not have had an opportunity to examine this masterly introduction, we shall cull a few examples, taken almost at random, of the mode of treatment which Dr. Murray and his coadjutors have followed. Almost every page will give us interesting material. A good many mathematicians who know that 'algebra' is an Arabic term will be surprised to find, that, so far as can be ascertained, it came into English use first (as early as 1541) in the sense of re-integrating broken bones, so that an algebraist or algebrista was 'a bone-setter,' and ten years later (in 1551), in the sense of the science of 'redintegration,' or equation, the mathematical sense which alone remains current. The historical use of another Arabic word, 'alcohol,' is likewise interesting. Its first recorded appearance in English is in 1543, when it meant any fine impalpable powder produced by sublimation, as alcohol of sulphur; and hence it was applied to fluids, an essence or spirit obtained by distillation, as alcohol of wine, and so ultimately to an extensive class of compounds of the same type as spirit of wine, some of which, far from being volatile, are not even liquid. The very convenient scientific group of 'actinic' words appears to have been introduced by Sir J. Herschel, who invented an instrument, which he called an actinometer, for measuring the intensity of the sun's heating-rays, described by him in 1825. More than a score of words etymologically related to this are now in scientific use. By and by we may expect a like multiplication from 'bolometer,' which Professor Langley has set in motion. 'Agnostic' is traced to a suggestion of Huxley's at a meeting of the Metaphysical society of London in 1869, and he had in mind the altar referred to by St. Paul as erected 'to the unknown God.' The first use of the term in print may be found in the *Spectator* for Jan. 29, 1870. 'Agnosticism' followed naturally a few months later. 'Ant' and 'emmet' have a common ancestry in the West Saxon *aemete*. In one form or another, they have been known to our language since the year 1000. 'Aluminium' first came into use in the form 'alumium,' which Sir Humphry Davy employed in 1808. Four years later he spoke of 'aluminum,' not yet obtained in a perfectly free state; and very quickly the *Quarterly review* substituted 'aluminium' for its less classical predecessor, and this is the form now commonly adopted. The biography of 'academy' is of interest. Caxton used the form 'achadomye' in 1474, referring to Plato's dwelling; but it was almost a century later (1549, 1588) when it began to be used as the name of a modern seat of learning. Perhaps it came to England from Geneva, where a protestant foundation took the name of an 'academy,' to be distinguished from the ecclesiastical 'university.' Toward the end of the seventeenth century the Royal academy of sciences in Paris was talked about in London; and in 1769 an academy of fine arts, that which is now in London *the* Academy, was founded. The American use of 'academical' as applying to an undergraduate classical college, in distinction from a scientific or professional school, does not appear to have been noted.

— Alabama may now be said to have a state weather service. As now organized, there is a corps of twenty-two observers working under the patronage of the state commissioner of agriculture, no appropriation having as yet been made by the legislature. The service was organized in February, by Dr. P. H. Mell,

jun., of Auburn, and now issues a monthly bulletin. It is hoped, that, during the next session of the legislature, the service may be placed on a permanent footing.

— The Massachusetts charitable mechanic association announces its fifteenth exhibition to open in September, 1884, and to continue for not longer than ten weeks.

— Professor Angelo Heilprin began a course of fifteen lectures on geology, before the Teachers' institute of Philadelphia, in the hall of the Academy of natural sciences, Wednesday, April 23.

— The Ottawa field-naturalists' club, which for five years has been engaged in developing the natural history of that district, has issued a circular calling attention to its success in the past, and urging its members and others to still greater exertions. The excursions the coming season are expected to be of especial interest, and through them it is hoped that many may be enticed to help in the scientific work. Observations of the migrations of birds are especially called for.

— What a blow it would be to the scientific farmer, if it should be proved that the Ohio floods are due to some extent to the large amount of drainage-pipe and ditches which have been introduced of late years! A writer in the *New-York herald* urges the farmers to turn their backs on the drain-tile dealer, and devote their energies to deep ploughing, that the rain may the better be absorbed.

— The *Missionary herald* for March prints the following account from Mr. Gulick, one of its missionaries in Japan: —

No matter how cold it is, shoes are not allowed in the clean, matted rooms of any Japanese hotel or dwelling. Slippers are permitted as a concession to the foreigner. After making your prostrations to your callers, the proper position for yourself and all your company is to sit in a circle about the brazier, while tea and cakes or candies are passed around. After the tea the inevitable pipe, each individual carrying his own, is produced. A little pinch of dry fine-cut, half the size of a pea, is pressed into the microscopic bowl: the gentleman bends forward on his knee with the long pipe-stem in his mouth, touches the pipe to a live coal, gives a suck, bloats his cheeks for a moment with the warm smoke, and then expels it in two streams from his nostrils; a second whiff, then with a sharp rap of the pipe on the side of the brazier, or of a box for the purpose, the ashes are expelled, and he is ready to repeat the dose, or, with an air of satisfaction, tucks his pipe back into his belt. Each member of the circle is likely to repeat this operation from five to fifteen times in an hour; and you, the one abstainer, have the full benefit.

This is but one of the discomforts. The polite manner of sitting — the only manner admissible in refined society — is another and very great one. Your caller is announced. He drops on his hands and knees, and touches his forehead to the mat: you do the same. Perhaps a second bow, and you ask him to be seated: modestly he subsides at a little distance to the rear. You urge him to come up to the brazier and warm his hands: he declines. You urge him again, and he crawls forward. You are seated; all are seated. Your instep and the top of your stockinged or slippered feet press the floor, while you sit back full weight upon your heels and the upturned soles of your feet, with your knees straight before you. You, or your travelling-companion, pass the tea and cake. You exchange a few words with your caller, perhaps spread the palms of your cold hands over the few red coals, and try to look serene and composed. If you are an average foreigner, and not of the loose-jointed kind, about five minutes in this position is all you can endure, and you are ready to exclaim, 'Who shall deliver me from bondage to Japanese etiquette?' Your agony betrays itself in your face, and one of your polite visitors begs you to unbend and stretch out your feet. Thankful enough, you relieve your aching ankles and knees by assuming the attitude of the Turk, or the Hawaiian, on the mats. Occasionally the hotel-keeper, or your host, knowing the weakness of the foreigner, offers you a chair. But as vain is the effort of the man in a chair to be sociable with those on the mats as for a man on horseback to identify himself with a company of foot-passengers. Half an hour of enforced endurance of the standard polite position will render the ripe foreigner as lame as a foundered horse. The once flexible knee-joint refuses duty. But then, the Japanese are the most polite people in the world, and they will pardon any attitude in one whom they know and respect.

— We learn from *Nature* that a London *Times* correspondent writes from Iceland that reports of a volcanic eruption in the interior were current last year, and were founded on peculiar appearances of the sky, and especially on the observation from some of the remote inland farms of columns of smoke or vapor rising in the far distance. Nothing definite has, however, been ascertained as to these phenomena. An unusually large number of scientific men, — geologists, botanists, and philologists, — chiefly German and Swedish, visited Iceland last summer, and investigated its structure, flora, and language; and at present Professor Sophus Tromholt, well known in scientific circles by his researches as to the aurora borealis, is pursuing these investigations there, and intends to remain all the winter, as, from the clearness of the atmosphere and the frequency and brilliancy of the aurora, Iceland is exceedingly well suited for his observations.

— Some figures relative to the effect of different forms of artificial illumination on health have recently been published in the English *Science monthly*. A tallow candle is far the most unhealthy agent, and the electric light the best. The heat produced by the incandescent lamp is only about one-thirtieth of that produced by the tallow candle, while there is no carbonic acid or water produced at all. It is said, one gas-jet in a room vitiates the air as much as six human beings in a room.

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